ECONOMICS GUIDE

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

Soil Conservation Service
United States Department of Agriculture
March 1964

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Washington, D. C. 20250

Elwood

January 28, 1971

ECONOMICS GUIDE

NOTICE No. 10

Attached are copies of Interim Chapter 15, Economic Projections, to be inserted in copies of the Economics Guide.

The chapter will be updated periodically to provide additional guidelines and realistic examples of uses for economic projections.

Attachment

Kenneth E Grant

Administrator

TABLE OF CONTENTS

Economic Analyses - Uses, Framework and Standards	Chapter 1
Application of Economic Analysis in Project Formulation	Chapter 2
Floodwater Damages and Benefits	Chapter 3
Restoration of Former Productivity, Changed Land Use and More Intensive Use of Flood Plain Land	Chapter 4
Sediment and Erosion	Chapter 5
Drainage Measures	Chapter 6
Irrigation Measures	Chapter 7
Municipal and Industrial Water Supply	Chapter 8
Recreation, Fish and Wildlife Development	Chapter 9
Cost Allocation and Cost Sharing	Chapter 10
Secondary Benefits	Chapter 11
Redevelopment Benefits	Chapter 12
Land, Easements, and Rights-of-Way	Chapter 13
Short Cuts in Evaluation Procedures	Chapter 14
Compound Interest and Annuity Tables	Appendix A
~~Appendix~~ B Agricultural Prices and Cost Projections	Appendix B
Miscellaneous	Appendix C

	Chapter	Page
C. Some Basic Principles	2	2
Evaluation and Formulation		2
Formulate to Include All Purposes		2
Favorable B/C Ratio		2
Separable Benefits and Costs		2
Meet Project Objectives		2
Provide Maximum Benefits		2
Departures from Scope of Project		2
Alternatives to Satisfy Purposes		2
II. Formulation of a Project		2
A. Determination of Watershed Problems		3
Locate and Define		3
B. Economic Criteria on the Level of Development Needed		3
Projections		3
C. Maximizing Net Benefits		4
Table 2.1 Illustrating this Principle		5
D. Evaluation Units		5
Economic Justification for Each Purpose		5
E. Planning a System of Single-Purpose Interdependent Structures		6
F. Economic Evaluation of a Single Purpose Structure with Multiple Benefits		6
G. Establishing the Economic Justification and Scale of a Multiple-Purpose Independent Structure		7
Use of Incremental Analysis with Tables		7
REF. Advisory Notice W-748 - Land Treatment Measures in Watershed Work Plans (9-28-62)		
FLOODWATER DAMAGES AND BENEFITS	3	
I. General Considerations in Damage Appraisal		1
II. Major Methods of Calculating Average Annual Damage		2
A. Frequency Method - Illustrated with Tables -		2
Runoff Related to Frequency of Occurrence		2
Runoff Versus Discharge (cfs)		2
Discharge (cfs) Versus Frequency		2
Discharge (cfs) Versus Flood Stage		2
Flood Stage Versus Area Flooded		2
Graphs to Evaluate Types of Floodwater Damage -		
Area Flooded Versus Damage		2
Flood Stage Versus Damage		2
Discharge Versus Damage		3
Damage Versus Frequency of Occurrence		3

	Chapter	Page
B. Historical Series Method Includes Short-cut Formulas to Adjust Damages for Recurrent Flooding	3	10
C. Overland Flow Alluvial Type of Flooding		14
D. Net Income Method		17
III. Steps in Damage Appraisal		18
A. Selection of Areas for Study		18
Sampling Techniques		18
B. Collection of Basic Data		19
Maps		19
Cost and Price Data		19
Collection of Field Information		19
Sample Flood Damage Schedules		20
C. Analysis of Damage		21
Sample Residential Flood Damage Schedule		22
Crop and Pasture Damage - Composite Acre		23
Other Agricultural Damage		27
Nonagricultural Damage		27
Roads and Bridges		29
Railroads		29
Residential		30
Residential - Acceler. Depreciation		30a
Other Floodwater Damage		31
Indirect Damage		31
Percentages for Estimating		32
IV. Benefit Evaluation		32
A. Off-Site Benefits		32
Reductions in Damages		33
Future Development in Absence of Project		34
Projecting Development Techniques with some Basic Assumptions		34
Increased Income		35
Upland to Floodplain Movement		35
Urban to Floodplain Movement		35
Distinguishing Between Enhancement and Future Development Without Project		36
Remaining Damage to Higher Values		36
B. On-Site Benefits		36

	Chapter	Page
V. Costs	3	37
A. Project Costs		37
Installation Costs		37
Operation and Maintenance Costs		38
Induced Costs - Caused by Project		38
B. Associated Costs		39
1/		
EVALUATION OF RESTORATION OF FORMER PRODUCTIVITY, CHANGED LAND USE AND MORE INTENSIVE USE OF BENEFITED LAND	4	
I. General		1
A. Agricultural Benefits		1
Restoration of Former Productivity		1
Changed Land Use		1
Intensification of Use		1
B. Non-agricultural Benefits		2
II. Basic Data Necessary for Evaluation		3
III. Constraints in Benefits from Allotment Crops		4
IV. Benefits from Restoration to Former Productivity with Tables 4.1 and 4.2		5
V. Evaluation of Changed Land Use from Low to High Agricultural Use. Table 4.3		7
VI. Evaluation of Benefits from More Intensive Use of Cropland. Table 4.4		7
VII. Benefits of Changed Land Use from Agricultural to Non-agricultural or More Intensive Use of Non-agricultural Property, with example.		11
VIII. Adjustments in Benefits		13
A. Lag in Accrual		13
B. Adjustments for Remaining Flood Damage to Higher Value Use		13
C. Other Adjustments to Consider		14
Failure to Take Advantage of Project Facilities		14
REF. Secretary's Memorandum No. 1518 - Development & Administration of Cropland Conversion Programs.		

1/ References, Chapter 3:
ADV. W-598 - Estimates of Shifts in Acreage and Use of Cropland in Watershed Projects.
Memos from B. L. Doneen, E&WP Unit.

	Chapter	Page
SEDIMENT AND EROSION	5	
I. Erosion and Sediment Damage to Agricultural Land.		1
A. Types of Land Damage		1
Erosion Damage		1
Sediment Damage		1
II. Methods of Evaluating Land Damage		2
A. Evaluation of Permanent Land Damage		2
Basic Determinations and Definition of Terms		2
Level of Production & Pattern of Land Use		2
Gross Income		3
Adjusted Gross Income		3
Real Estate Tax Charges		3
Returns to Land		3
Returns to Labor, Capital, Management		4
Procedure for Erosion Damage Evaluation		4
Illustration of Procedure - Tables 5.1, 5.2, 5.3, 5.4, 5.5		4
III. Evaluation of Damage to Improvements from Gully and Streambank Erosion		15
A. Where Relocation of Property is Feasible		16
B. Where Gullying is Expected to Damage a Highway		16
C. Where it is Not Feasible to Relocate a Structure or Business		16
D. Where Relocation of Business or Property is Feasible.		16
IV. Evaluation of Sediment Damage to Railroads and Highways		17
V. Evaluation of Sediment Damage to Municipal and Industrial Water Supplies.		17
VI. Evaluation of Sediment Damage to Existing or Non-Project Drainage and Irrigation Facilities		19
VII. Evaluation of Reservoir Sedimentation.		20
Example of Evaluation Methods		20

	Chapter	Page
DRAINAGE MEASURES	6	
I. Basic Data		1
A. Soils		1
B. Land Use and Crop Yields		1
C. Production Data - Crop Budgets		2
II. Benefits		2
A. Source		2
Land Use Changes - "new" Land Included		2
More Intensive Use		2
Reduced Production Costs		3
Improved Resource Allocation		3
B. Evaluation		3
Agricultural Income With and Without Project		3
Allowance for Lag in Accrual		3
Division of Benefits Between Drainage and Flood Prevention		4
III. Costs and Cost Estimating		4
A. Types of Costs		4
Project Costs		4
Associated Costs - Land Treatment Included		5
Induced Costs		5
B. Cost Analysis		5
Amortization Period		5
Annual Cost		6
IRRIGATION MEASURES	7	
I. Basic Data		1
A. Water Supply, Water Rights, Water Quality		1
B. Soils		1
C. Land Treatment Needs		1
D. Consumptive Use by Crops		2
E. On-Farm Irrigation Efficiency		2
F. Land Use and Crop Yields - Present & Future		2
G. Partial or Complete Budget Analysis		3
II. Benefits		4
A. Source		4
Land Use Changes		4
More Intensive Use		4
Reduced Production Costs		4
Improved Allocation of Resources		4
Reduced Project O&M Cost		5

	Chapter	Page
B. Agricultural Income With and Without a Project	7	5
Full and Partial Application Possibilities		5
Land Treatment Measures		5
Water Conveyance Facilities and Delivery Schedule		5
Meeting Needs		5
C. Evaluation of Benefits to the Irrigation Measures		6
Allowance for Lag in Accrual		6
III. Costs		
A. Type of Costs		6
Project Costs - Examples		6
Associated Costs - O&M, Land Treatment, etc. with Examples		6
Induced Costs		7
B. Cost Analysis		7
Amortization Period		7
Annual Cost		7
1/		
MUNICIPAL AND INDUSTRIAL WATER SUPPLY	8	
I. Responsibilities in Evaluation		1
A. Sponsoring Organization		1
B. Soil Conservation Service		1
II. Analysis by the Service		1
A. Data Required		1
Data Furnished by the Sponsors		1
Data Accumulated by SCS		2
B. Benefit Determination		2
C. Deferred Use of a Municipal or Industrial Water Supply		3
D. Essentials for Justification of Inclusion of Municipal or Industrial Water Supply in a Project		3
2/		

REFERENCES:

1/ Watershed Memo SCS-61 - Policy for Advancing Funds for the Acquisition of Land, Easements or Rights-of-Way.

2/ Watershed Memo SCS-62 - Policy for Providing Storage Capacity in Structures for Future Municipal or Industrial Use.

	Chapter	Page
RECREATIONAL AND FISH & WILDLIFE DEVELOPMENT	9	
I. Collection of Basic Data		1
A. Data from Similar Developments - Other Studies		1
B. Projections		2
C. Competitive Facilities		2
D. Environmental Factors		3
II. Recreation as a Project Purpose		3
A. Types and Seasons of Recreation		3
B. Analysis of Use		3
C. Assignment of Unit Values for Recreation(Value of Visitor-days)		4
D. Determination of Benefits		4
E. Appraisal of Costs		5
Amortization of Installation Costs with Examples		5
Operation and Maintenance		5
III. Incidental Recreational Benefits		6
A. Types of Use		6
B. Determination of Use		6
C. Assignment of Unit Values		7
Costs of Providing Facilities		7
Personal Services Required		7
Risks Associated with Use		7
D. Determination of Benefits - Methodology		7
IV. Fish and Wildlife Benefits		7

REFERENCES:

Recreation Memorandum SCS-3 - Preparation of a Book of Recreational Referenc
Advisory REC WA-17 - Tech. Guide, Sec. V-C Cost & Return Data, Income-Producing Recreation Enterprises.
Watersheds Memo SCS-58 - Policy for Recreational Develop. in WS Projects.
Watersheds Memo SCS-59 - Policy for Fish & Wildlife Develop. in WS Projects.
Watersheds Memo SCS-57 - Evaluation of Recreation, Redevelopment and Secondary Benefits for Economic Justification of WS Projects.
Watersheds Memo SCS-63 - Recreational Development.
Secretary's Memo No. 1516 - Income-producing Recreational Enterprises on Rural Non-Federal Lands
Public Recreation in Watershed Projects (Summary of Cost-sharing)

	Chapter	Page
COST ALLOCATION AND COST SHARING	10	
I. Cost Allocation		1
A. Definition of Terms and Their Use in Cost Allocation		1
Alternate Cost		1
Separable Cost		2
Specific Cost - Exclusive to One Purpose		2
Joint Cost		2
B. Reservoir-Type Structures - Methods		2
Use of Facilities Method with Example		2
Alternative Justifiable Expenditure Method		4
Separable Cost - Remaining Benefits Method with Tables and Examples		4
C. Multiple-Purpose Flood Prevention and Drainage Channels		6
First Alternative - Method		6
Second Alternative - Method		7
Percentage of Wet and Non-Wet Land to Total area Benefited - Method Using Portion of first two Alternatives		8
Allocating the Cost of a Part of a Channel system Serving a Single Purpose		9
II. Cost Sharing		10
See Watershed Protection Handbook and Watershed Memoranda		
SECONDARY BENEFITS	11	
I. General		1
A. Definition		1
B. Theory of Derivation		1
Increased Production - "Stemming from"		1
Added Purchases - "Induced by"		1
C. Zones of Influence		2
Limitation		2

	Chapter	Page
SECONDARY BENEFITS (Con.)	11	
II. Benefits - "Stemming from" and "Induced by"		2
A. Application		3
B. Examples		3
C. Secondary Losses		4
REF.: WS Memo SCS-57 - Evaluation of Benefits for Economic Justification of Watershed Projects.		
REDEVELOPMENT	12	
I. Background		1
A. Areas of Chronic Unemployment or Underemployment		1
B. Need for Outside Assistance		1
C. Effects of a Project		1
II. Types of Redevelopment Benefits and Their Evaluation		1
A. Project Installation - Employment and Local Purchases		2
B. Project O&M - Permanent Job Creation		2
C. Employment Stemming from Use of Project Improvements - Introduction of New Industry		3
D. Other Possible Redevelopment Benefits		4
1/ LAND EASEMENTS AND RIGHTS-OF-WAY	13	
I. Responsibility		1
II. Land Rights		1
A. Fee Title - Definition		1
1. Method of Acquisition		1
Negotiation		1
Condemnation Proceedings		2
2. Fair Market Values - Principles to Apply		2
B. Easements - Principles		3

REFERENCES:

1/ News Release by Orville Freeman re RAD, etc.
Secretary's Memorandum No. 1517 - Rural Renewal Program.
Secretary's Memorandum No. 1515 - Resource Conservation and Development Projects.

	Chapter	Page
LAND EASEMENTS AND RIGHTS-OF-WAY (Con.)	13	
III. Methods of Estimating Values		4
A. Market Data Approach		4
B. Capitalized Value of Net Income		4
C. Cost Approach		4
IV. Land Rights Costs to be Included in the Economic Evaluation		5
1. Other Economic Costs		5
SHORTCUTS IN EVALUATION PROCEDURES	14	
I. Purpose of Shortcut Procedures - Feasibility of Use		1
II. Conditions Conducive to Effective Use of Shortcuts		1
A. Broad Knowledge of Problem		1
B. Known General Outcome		2
C. Size and Complexity of the Project		2
III. Possible Shortcuts		3
A. Empirical Relationships		3
B. Analysis of Needs		3
C. Opportunity Cost Principle		4
D. Analagous Situations		4
IV. Checks and Balances		4
A. Usual Statistical Tests		4
B. Multiple Checks		5
C. Reasonableness		5

c. Residential Damage - Accelerated Depreciation

An alternative method of determining the annual damage reduction benefit to residential property is through the use of a factor for accelerated depreciation.

This applies in many instances where a high water table or frequent shallow inundation occurs. Unless precautions have been taken during the construction phase of the houses, dry rot of sills and joints will occur. Measures taken after construction have questionable worth. An example here would be a plastic vapor seal or additional ventilation.

In cases of this nature, the damages in many instances have not yet become apparent to the residents. This is especially true if the residences were recently built; that is, within ten years. An attempt must be made to determine the average rate of occurrence through such sources as local contractors, residents who have experienced damage, lending agencies and real estate firms that handle property in the affected zone. From these interviews it should be possible to estimate a depreciation rate for the residences. The standard rate of depreciation for residences outside the damage area can be determined by the use of the same methods and will serve as the "without" condition.

An example would be:

A residence valued at $10,000 in the unaffected area will be fully depreciated in 50 years. This rate is 2% per year. The annual depreciation is $10,000 x .02 = $200.

A residence of equal value in the affected area may need to be depreciated in 35 years. This rate is 2.86% per year. The annual depreciation then becomes $10,000 x .0286 = $286.

The difference between the two is the annual average damage (in this case $86) for this residence.

Inserted by Curt Mader, 5/17/66

Sensitivity Analysis

CHAPTER 1

ECONOMIC APPRAISALS - USES, FRAMEWORK AND STANDARDS

This chapter deals primarily with the application of basic economic theory in the appraisal of watershed projects. The first section deals with the uses of economic appraisals. The second discusses the appraisal framework and standards.

I. USES OF ECONOMIC APPRAISALS

The primary purpose of benefit-cost analysis is to provide a basis for determining if a proposed project is economically justified. In addition such analyses should also (a) establish the need for a project, (b) provide guidance for project formulation, and (c) measure the relative economic desirability of different measures and groups of measures to meet agreed-upon project objectives. The economic analysis may also be helpful as a basis for the allocation of costs among purposes and for assessing cost to beneficiaries.

A. Need for Improvement Measures

The first step in the development of a watershed work plan is to identify and measure the water related problems of the watershed. This will include consideration of the following: (1) the severity of erosion losses, (2) the losses resulting from sedimentation, (3) the extent and severity of floodwater damage, (4) the restriction imposed upon the use of the land by poor drainage, (5) the need for, and problems associated with, irrigation in areas or under conditions where required to realize full economic agricultural potential of the lands, (6) the restriction imposed upon the use of land by frequent flooding, and (7) the need for other agricultural water-management measures, municipal water supply, recreational and fish and wildlife development. Each of the above determinations, to be of greatest usefulness, should be expressed in economic terms. Such evaluations, when compared with costs on a standardized basis provide a basis for: (a) determining the objectives for each of the purposes included in a project, (b) estimates of the types and amount of watershed improvement measures to meet these needs and objectives, and (c) determining the economic justification for the project.

B. Guidance for Project Formulation

Once the watershed problems have been determined, the next step is reaching tentative agreement with the sponsors on project objectives. Then the types of measures must be selected which will alleviate the problems and meet the watershed needs effectively. Although economic consideration must be blended with other considerations such as policy, engineering, institutional, legal and local desires, economic principles are basic in formulating a project. Economic analysis will point to types and intensity of development needed and thereby aid in determining the appropriate level of project objectives. Analysis of trends and potentialities may emphasize the need to plan the project to meet future needs that otherwise would not be apparent.

While achievement of equi-marginal returns in the development of all watersheds may be an unobtainable goal, project formulation in accordance with economic principles will be a step toward that goal.

Uses of economics in project formulation are described further in Chapter 2.

C. Relative Economic Desirability

A ratio of benefits to costs of greater than one to one usually is regarded as an indication that the proposed work is economically desirable. This assumes, of course, that adequate financial and other resources (both Federal and non-Federal) are available. Because this may not hold in each situation, an economic analysis should be made for each of several alternative systems of interrelated measures which are most likely to meet project objectives. The system which provides the greatest economic efficiency and which has the greatest possibility of installation should be selected. To facilitate construction and assure that any measures installed will provide benefits at least equal to their costs, benefits which will accrue to individual measures or groups of measures within a system should be identified. This requires that a number of separate evaluations be made in a given watershed, including those for subdivisions of the measures and subdivisions of the watersheds. The physical interdependence of many measures, however, reduces the number of possible seperate appraisals.

D. Guides for Financing

Authorized purposes may be included in a watershed project only if they are economically justified. Careful economic analysis is needed to make sure that no purposes are included that lack economic justification and hence would constitute an inequitable financial burden upon some of the interested participants in the project. This analysis may serve the added purpose of aiding the local sponsoring organization in its financing and assessing problem by indicating the kind of benefits and the broad groups of beneficiaries of the project.

II. APPRAISAL FRAMEWORK AND STANDARDS

The primary function of an evaluation is to provide assurance that effective use can be made of the resources required by proposed watershed projects. To allow necessary comparisons, project evaluations need to be made in accordance with a set of uniform concepts, principles and standards. A set of guides of this kind form the conceptual framework and the analytical apparatus for making an evaluation analysis. The purpose of this section is to review the basic assumptions and principles that underlie the benefit-cost analysis and to indicate general standards and criteria considered appropriate for their application. Aspects covered include principles, concepts and basic assumptions; pricing of project products and services; interest and discount rates and the evaluation period.

A. Basic Principles, Concepts and Assumptions

Watershed development involves the production, conservation, and use of economic goods and services related to land and water. Economic goods and services encompass all objects and services that are limited in supply and have the power of satisfying wants. The basic objective in economic evaluation is to compare the value of the goods and services produced or conserved with that of the costs incurred, after full account is taken of all project effects. For comparable results, it is necessary that uniform standards be used for pricing project goods and services; effects be evaluated from a similar viewpoint; an appropriate basis be used for determining the effects that may be attributed to a project; and consistent assumptions regarding the general economic setting be used.

1. Expression in monetary terms

Beneficial and detrimental effects arise initially in many physical forms, accrue at different times, continue for varying periods, and arise under a variety of circumstances that influence the probability of their occurrence.

Monetary estimates constitute the most practical means of expressing diverse physical effects in comparable terms. Dollars provide a measure of the relative values of different types of effects at the time of their occurrence. Prices provide a system that may be used to convert various and sundry physical effects to a common value. In a market economy, the price system becomes the principal device for bringing about a balanced allocation of resources among competing uses. Prices operate to limit the use of scarce resources and services to meeting needs in accordance with the market rating of their importance. Most watershed projects involve the production, conservation, or use of goods and services that reasonably may be evaluated in terms of market prices.

However, it must be recognized that the values attached to goods and services by the market may not always accurately reflect values from a public viewpoint. This is due in part to the existance of imperfect markets and the influence of such factors as subsidies, tariffs, price supports and surplus commodities. Also, the market measures only the value of marginal units, rather than the total value of the segment subject to change. While it is extremely difficult to give precise quantative expression to certain of these considerations, the general principle that project services or products have value only to the extent that they are needed is inherent in any economic evaluation. Despite limitations of the market as a measure of public values, there is no other suitable framework for evaluating in comparable terms the effects of watershed or other types of projects. Accordingly, market prices are considered the essential starting point for an economic analysis.

To the extent feasible, project effects which are ordinarily evaluated incompletely or not at all in actual market exchange may be given a derived or estimated monetary value. Types of benefits and costs that

cannot be covered by actual or derived market prices still warrant consideration. Intangibles not susceptible of monetary measurement need to be weighed and described in a way that indicates their importance and influence on project formulation and evaluation.

2. Applicable Viewpoint

The viewpoint from which the analysis is made must be consistent for the particular purposes to be served by the analysis. The appropriate viewpoint for the evaluation of projects involving substantial Federal investments is that of a comprehensive National or public viewpoint. Primary emphasis in this viewpoint is placed on taking full account of all significant beneficial and adverse effects. The adequacy of the results obtained depends to a considerable extent on how completely measurement from a comprehensive public viewpoint can be realized; that is, how fully all effects on individuals and the public as a whole can be traced and evaluated in comparable terms. The sum of beneficial or adverse project effects accruing to individuals is likely to fall somewhat short of full coverage from a public viewpoint. Types of beneficial or adverse effects that accrue to the public as a whole may not be considered fully in the value judgements of individuals or local interests. Examples include the value of resource conservation to future generations; effects on health, welfare and National security; and various other effects that are widely dispersed or not directly apparent to those eventually effected.

Application of a comprehensive public viewpoint often requires making a reasonably sharp distinction between economic feasibility on the one hand, and cost-sharing and reimbursement considerations on the other. The viewpoints involved are basically different. In an evaluation from a public viewpoint, the effects properly subject to consideration include various types of offsets that arise in other localities or geographic areas. For cost-sharing, the appropriate viewpoint is usually local in nature and little attention needs to be given offsetting effects outside the area of project influence. In an evaluation from a local viewpoint, the benefit basis for cost-sharing might differ from that available for justifying a project from a National or public viewpoint. Secondary benefits from an area or local viewpoint are likely to be more substantial than from a National viewpoint.

The applicable viewpoint also has a bearing on the standards selected to measure values. The standards for evaluation may differ from those considered appropriate for reimbursement. For example, where cost-sharing involves entering into contractual obligations expressed in dollar terms, price fluctuations and trends become much more significant than in an evaluation from a public viewpoint, where the emphasis is on "real" value relationships. While the procedures and standards applied for evaluation should reflect an overall public or National viewpoint, supplemental analyses based on local and regional viewpoints are needed where pertinent for cost-sharing purposes.

3. Least costly alternatives

Within the limits set by legislation, policy or other constraints, any project or segment selected for installation must satisfy the requirement that it not be more costly than any reasonable alternative means of accomplishing the particular objective contemplated.

No purpose should be recommended if a less costly means of accomplishing essentially the same purpose would thereby be displaced or economically precluded from development as a result of the project.

All practical alternative possibilities within the scope of watershed program activities should be taken into account. In practice, alternatives subject to consideration are likely to be limited by budgetary and areal considerations and the information available.

4. Ascribing effects to a project

A uniform basis for attributing effects to a project is needed in order that results be comparable. The generally accepted basis is the "with" and "without" approach, in which the differences in expectations provide the basis for identifying appropriate project charges and credits. It is assumed that the goods and services used for project purposes normally are diverted from the least important uses otherwise expected. Accordingly, the cost in terms of market values usually provides an adequate measure of the value of benefits foregone.

The basis for determining benefits that may be credited to the project is similar. The project should be credited with the difference between values with the project and those expected from using the watershed resources in some other way without the project. The primary benefits attributable to the project are the total primary benefits, less the cost of the goods and services used that are not otherwise taken into account. As with costs, the value of the benefits produced is their exchange value, as measured by expected market price at the time of accrual.

The "with" and "without" approach becomes an analytical device for determining the effects of various purposes, features and incremental segments both in the evaluation phases of the economic analysis, as well as in project formulation. The amount of credit that is due to any addition (or deletion) in the program becomes the difference in the expected effects with and without the particular change under consideration. In providing a basis for measuring the effects of incremental benefits and costs, the approach is essential to the formulation of projects so as to maximize net benefits.

5. Basic assumptions

Evaluation standards and procedures should be based on consistent assumptions regarding economic trends and expected levels of resource employment. The assumption of a continuously expanding economy for

both "with" and "without" conditions would appear appropriate as a general basis for estimating price and requirement expectations. Under such a setting, increasing amounts of goods and services would be required to satisfy the needs of an expanding population and provide for higher levels of living. An eventual demand would develop for all types of goods and services that can be provided at reasonable cost. At the same time, it would be expected that other uses normally would be available for the resources required by the project.

This would result in resources ordinarily being considered scarce in the sense that all would be required under the economic conditions expected to prevail, either with or without the project. Resulting assumptions include the expectation that project required resources usually would be diverted from other uses; such diversions would be from marginal or least important other uses; and market prices would measure the values in such uses.

The high level of resource employment assumption does not preclude consideration of short run fluctuations in the economy. Allowances for unusual local situations may need to be included in the analysis of a specific project, including the lack of mobility of some resources.

B. Pricing Project Products and Services

The prices applied should reflect purchasing power values expected to prevail at the time benefits accrue or costs are incurred. Thus current prices or price relationships are appropriate for valuing costs of installation in the immediate future. Projected prices should be used for all effects occurring over time. These effects include benefits and costs of operation, maintenance, replacement and deferred installation.

Typical types of price projections for measuring future effects are: current prices, average prices over a period of years, "normalized" current prices, or definite price projections such as those prepared by the Department of Agriculture in September 1957.

1. Special pricing problems

State projections may require adjustment to reflect situations in particular watersheds. This usually involves adapting State projections to the watershed area on the basis of relationships between area and State prices during a base period. The projections used should be consistent for adjoining watersheds separated by State lines, which may at times necessitate the use of average relationships for combined areas and corresponding states. In general, it would appear feasible to make most of the necessary adjustments through applying conversion factors or price relationships computed from the price pamphlet directly to a comparable year base for the area.

Special consideration needs to be given the rare situations where project production is expected to affect previous price relationships.

Where project production is sufficient to cause a shift from a deficit to a surplus production area, such a change would need to be taken into account in the price projections applied. The use of past relationships in market areas comparable to those expected under project conditions may provide a basis for such adjustments. This special pricing problem is not likely to occur, however, on P. L. 566 watersheds, except in small isolated mountain basins or in sparsely settled areas in the West. Occasionally it may be a factor in river basin development.

Products for which price projections have not been computed should be estimated on the basis of available projections for the most nearly similar group.

C. Interest and Discount Rates

Interest and discount rates provide the basis for converting values estimated as of the time of accrual to a common time and risk basis. In an evaluation from either a private or public viewpoint, allowances must be made for any differences in time and uncertainty that may arise during the period between the investment of resources and the accrual of benefits. Prevailing interest rates for loans and investments in the Private Market may be regarded as reflecting both "time" and reasonably high "risk" components. In contrast, long-term investments in watershed protection and flood prevention reflect minimum "risks" components that suggest an interest rate lower than prevailing private market rates. Direct or specific allowances for risks of the predictable type should be made to the extent feasible when evaluating projects from a public viewpoint. This leaves the interest and discount rate as a measure of value differences due to time, together with residual risks and uncertainty.

1. Interest rates

As with prices for all types of economic goods and services, the need for an interest charge for capital stems from its scarcity. In order to be scarce, resources must be both wanted and limited in supply. The cost to society of capital utilization is determined by the productive opportunities over time that are foregone.

2. Applicable rate

Future project benefits will be discounted, project annual costs computed, and project benefits and costs converted to a common time basis by the use of current long-term Federal interest rates as issued annually by the Treasury Department.

Capital costs, such as land leveling or clearing, incurred by private beneficiaries to obtain the project benefits (associated costs) should be converted to their annual equivalent at the prevailing local interest rate for such expenditures.

D. Risk and Uncertainty Allowances

The evaluation of all projects involves projections into the

future where the outcome cannot be predicted with certainty. Allowances and adjustments may be necessary to reflect this situation. These allowances and adjustments may take the form of using a benefit to cost ratio significantly greater than unity, conservative estimates of benefits, contingency allowances, and periods of analysis short of expected economic or physical life or higher interest rates to allow for uncertainty.

E. Period of Analysis

The economic life of projects is limited by such factors as deterioration, obsolescence, depreciation, changing needs, and improvements in technology. Discount for time, and risk and uncertainly also limit economic life. The effective economic life is established at that point where the present worth of costs for extension exceed the present worth of the resulting benefits.

Economic life provides an appropriate basis for formulating the scale and scope of projects that serve the public interest. Formulation based on either a longer or shorter period would reduce net benefits.

1. Selected evaluation period

For purposes of project formulation and evaluation, the period to be used for estimating project benefits and costs should not exceed project economic or effective physical life or 100 years beyond the completion of project installation, whichever is less.

2. Evaluation period benefits and costs

The annual costs chargeable during the evaluation period include amortization with interest of initial installation costs; conversion of the costs of major replacements to be installed during the period to an annual equivalent; and operation and maintenance costs of a level sufficient to assure effective operating capacity to attain the level of benefits claimed for the project. The annual equivalent of replacement costs may well be considered as a type of operation and maintenance. The replacements are necessary for operation of the project, and the costs are to be borne by the sponsoring organization.

The benefits attributable to the evaluation period include those accruing over the period, reduced to an average annual equivalent, together with any remaining salvage productivity values available at the end of the period, reduced to an average annual equivalent.

CHAPTER 2

APPLICATION OF ECONOMIC ANALYSIS TO PROJECT FORMULATION AND ANALYSIS

I. GENERAL

This chapter treats the application of economic analysis in the actual project formulation process.

A. Objectives

The measurement of benefits and costs is an essential part of the process of formulating and evaluating project purposes that will be economically sound and give the best possible combination of eligible measures to meet project needs and objectives. In the formulation stage, it is necessary to consider existing and probable future economic conditions, the need for project development, the physical possibilities for project action and the most practical means available for realizing the desired objectives.

In a broad sense, the process of project formulation and evaluation, within the framework of the legal and policy constraints discussed below, is largely a problem of weighing alternatives. The overall planning objective is to select the measures or combination of measures that will meet the watershed needs and yield the greatest possible gain at the least cost.

B. Legal and Policy Constraints

There are a number of legal and policy constraints within which watershed projects must be formulated.

1. Some of the important legal constraints are: limits on the size of watersheds, size of floodwater retarding structures, flood prevention storage capacity in individual structures, etc. These and other legal constraints are contained in the Watershed Protection and Flood Prevention Act (P. L. 566, as amended).

2. Some of the more important policy constraints that influence project formulation are:

a. Land treatment measures are the basic element of any watershed project and shall be considered the nucleus or initial increment for project formulation. All other measures shall be justified for inclusion in the project on the basis that the land treatment measures scheduled for completion in the watershed work plan have been installed.

b. Agreement must be reached with the sponsoring local organization as to the level of protection to be provided for flood prevention and the objectives to be attained by each of the other project purposes included in the plan.

c. In project formulation, the requirements are: (1) The least costly system of structural measures needed to achieve the agreed-upon objectives in b above be developed to supplement the land treatment measures giving preference to floodwater detention as the means of affecting flood damage reductions. (2) Evaluate the benefits that will accrue to the system. (3) If the sponsoring local organization and the Service agree that it is desirable, increments may be added to the basic system to the extent that they produce benefits in excess of their costs.

C. Some Basic Principles

Within the framework of the constraints listed above, a number of important principles should be followed when using economic analysis in formulating and evaluating projects.

1. Projects shall be formulated initially to include all agreed-upon purposes which satisfy these criteria in quantitive terms:

a. Tangible net primary benefits exceed project economic costs.

b. Each separable unit or purpose provides benefits at lease equal to its costs.

c. The scale of development is such as to (1) meet project objectives, and (2) provide the maximum net benefits.

2. Plans should indicate the extent to which departures from the scope or scale of development are proposed in order to take into account intangibles or other considerations warranting a modification in the initially formulated plan. For example, a higher degree of flood prevention than is feasible on the basis of tangible benefits alone, may be justified where such protection is essential to protect against the threat to lives, health, or danger or serious economic dislocation. Or if long-range water needs are foreseeable in general terms where alternative means of meeting the needs are not available and additional capacity can be included initially at a significant savings over subsequent enlargement, such considerations may justify the additional cost required.

3. All reasonable alternatives that will accomplish the purpose and objectives of the project should be considered to the extent practicable and feasible during the process of project formulation and evaluation. Although flood proofing, flood plain zoning, and the like will be considered as a means of meeting project objectives, alternative cost comparisons will be limited to works of improvement authorized under the Act.

II. FORMULATION OF A PROJECT

During the process of project formulation, it is necessary to evaluate the physical effects of potential project measures in order that cost-benefit comparisons can be made. The benefits and costs should be estimated in accordance with the principles outlined in this and the

preceding chapter. Procedures for application of these principles in the measurement of benefits and costs of each project purpose are discussed in succeeding chapters of this Guide. In this chapter, evaluation procedural details will only be used to the extent necessary to illustrate the use of some of the important economic principles and concepts in project formulation and evaluation.

A. Determination of Watershed Problems

An essential first step in project formulation and evaluation is to locate, define and measure the significant watershed problems. This step involves answers to a series of questions, such as the following:

Is there a floodwater damage problem in the watershed? If so, what kind of damage occurs, its location and the annual amount in dollars? Is there a sediment damage problem? Where are the sediment source areas? What is the magnitude of sediment damage in dollars? Is there a need for irrigation or drainage, municipal and industrial water supply, recreational development, fish and wildlife development? Are there potentialities for more intensive or changed land use in the area? These and other economic and physical determinations will suggest possible solutions to the problems of the watershed. At this stage, the various physical solution possibilities can be evaluated in a preliminary way and the obviously unjustified means eliminated. Thus, economic analysis at this stage serves the important function of pointing out watershed problems, their location and their magnitude and suggests tentative solutions.

B. Economic Criteria on the Level of Development Needed

Economics has a function in determination of the project purposes and the degree of development to be sought. Projects should be planned to meet future needs insofar as they can be foreseen. Modifications of structures already built usually are more expensive and less satisfactory than inclusion of the features at the time of construction.

Economic analysis will point up the needs of a given area and potentialities for development. For example, the appraisal of opportunities for recreational development includes projections of population growth, analysis of potential competitive recreational possibilities, and consideration of complementary resources, as well as the physical possibilities of development.

The degree of development needed is directly associated with the potentialities of the area to be developed. In flood prevention, the degree of protection should not be the same for all watersheds but should be tailored to the values to be protected and the potential project induced land use changes. If an area is in truck crops where the direct production outlay is upwards of $100 per acre, a higher degree of protection is needed than if it were in small grain where the farmer has perhaps $15 of production costs invested per acre.

Consideration only of the existing situation is not enough. The planning should take into account the probable development in the future. Will an idle flood plain become productive if it is protected? What can be expected in the way of industrialization of an urban area if it is protected against flooding and an adequate water supply is provided?

It can be seen that the use of economics is not confined to the evaluation of a project already formulated. Instead it applies throughout the formulation process; to the purposes served, to the degree of development needed, and even to the location of measures to meet specific needs most efficiently.

C. Maximizing Net Benefits

From an economic viewpoint, the optimum scale of project development is the point at which the net benefits are at a maximum. Net benefits are maximized when the benefits added by the last increment of scale or scope of project development are equal to the cost of adding that increment. The increments to be considered in this way are the smallest increments in which there is a practical choice as to inclusion in or omission from the project. In watershed projects these increments usually occur as slugs rather than as smooth-curve type increases.

There are two places where this economic principle becomes applicable when formulating watershed protection and flood prevention projects.

The first is in that step in project formulation of developing the least costly set of measures to meet the minimum agreed-upon levels of protection and other project objectives. The essential point to keep in mind is that within reason all possible alternatives should be considered that will accomplish the objective at the least cost and at the same time maximize net benefits within the objective.

The second is in those cases where it is mutually agreed by the local sponsors and the Service, to strengthen the system of measures formulated in the first step by adding new increments so long as such additions will maximize net benefits at a higher level. This is illustrated by the data shown in table 2.1. It has been determined that structures numbers 1 and 2 will meet the objective of providing an adequate level of flood prevention at the least cost $12,800 annually and will provide an excess of annual net benefits over costs of $6,200.

Suppose it has also been determined through mutual agreement between the sponsors and the Service that a higher degree of protection than the minimum required to meet project objectives is considered to be desirable.

In order to establish the point where net benefits are at the maximum, further increments are added to the basic system of two structures and their incremental costs and benefits determined. By adding structure number 3, the annual cost is increased only $1,500 and the benefits increased by $1,700. The next increment, or structure number 4 can be added at a cost of $6,000 with an increase of $6,100 in benefits.

By adding structure number 5, costs are increased $6,700 but benefits only increase $5,000. Thus, the last addition has gone beyond the point of maximized net benefits because the cost of the increment is greater than its benefits. The total net benefits for the 5 structures will be less than for the system of 4 structures, $4,800 as compared with $6,500. Thus, the 4-structure system maximizes net benefits and would be the upper limit that could be included on the basis of tangible benefits alone and still comply with the policy constraint set out in I, B, 2, c.

Table 2.1 - Total Annual Costs and Annual Benefits; and Incremental Cost and Incremental Benefit for Alternative Floodwater-Retarding Reservoirs 1/

Structure	Annual Costs		Annual Benefits		
	Total	Incremental Costs	Total Benefits	Incremental Benefits	Net Benefits 2/
(No.)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1 and 2	12,800	-	19,000	-	6,200
3	14,300	1,500	20,700	1,700	6,400
4	20,300	6,000	26,800	6,100	6,500
5	27,000	6,700	31,800	5,000	4,800

1/ Data are hypothetical.

2/ Total annual benefits minus total annual costs.

D. Evaluation Units

Each purpose to be included in a project must produce incremental benefits at least equal to its incremental costs. Therefore, project evaluation requires as a minimum the determination of the economic justification of each purpose. When a project includes several purposes it may be that some conflict and others are complementary. This is especially true with multiple-purpose structures where inclusion of several purposes may reduce the cost of each but create competition for a limited water yield or physical capacity.

Within a given purpose the first unit for evaluation should be the scale of development that will meet the minimum needs for that purpose. For example, if it has been determined that an irrigation project needs a firm water supply of at least 500 acre-feet annually, there is no point in evaluating a project that will supply but 250. Were the inadequate project to be installed, farmers probably would incur additional crop production expenses in anticipation of irrigation and find themselves in worse shape than if no water supply capacity had been provided. Likewise, inadequate flood protection may engender a false sense of security and encourage flood plain development too great for the risk remaining.

In project formulation consideration needs to be given to the interrelationship of structures. Such an interrelationship generally exists when a group of structures protect a common flood plain. Here the most economical system for attaining the agreed-upon minimum level of protection may be evaluated as a unit. However, other structures that

protect a discontinuous flood plain should not be included in this evaluation unit. An example would be structures on several streams that flow into a major flood control reservoir at separate points when there is no damageable area between them.

Policy, legal and other constraints must be considered in selecting the units for evaluation. It is possible that in some cases flood prevention benefits might be maximized if emergency spillway flows were permitted on an average recurrence interval of 10 years. However, if safety considerations dictate that such flows cannot be permitted more often than on an average of once in 25 years, it would be pointless to analyze the 10-year interval.

E. Planning a System of Single-Purpose Interdependent Structures

Usually, in planning projects, situations will be found where several proposed structures are interrelated in such a manner that each contributes to flood damage reduction in a particular reach or reaches of a flood plain, and removal of any one structure from the system will change the degree of protection afforded by the system. In this situation, the economic analysis can be handled in several ways, depending upon the amount of basic physical and economic data that will be available for analysis.

A simple approach is to select first a group or combination of structures that will give the desired level of protection at the least cost, then test the total group for economic feasibility. Under this approach, the group of measures selected for the first test of economic justification is obviously a very important step in the formulation and evaluation of a project. The skill with which this selection is made will influence the amount of future work required to formulate the most desirable project for the watershed. This selection necessarily depends on judgment in considering the degree of protection desired and the structures which appear most effective. If the ratio of benefits to costs for the selected group is favorable, and if mutually desired, the feasibility of adding successive increments to the system up to the point where benefits are maximized may be undertaken.

If the first group of structures do not prove to be economically feasible, alternative sets of structures that will meet the needs of the project could then be selected for evaluation. When this is the case, certain structures usually are "key" structures and would be needed in any alternative plan. The study often can be confined to selection of alternates for the less efficient structures. Unusually high cost structures can be examined to see if minor relocations can reduce costs.

F. Economic Evaluation of a Single Purpose Structure with Multiple Benefits.

In the economic analysis of structures designed for a single purpose, such as detention or storage of water, cases frequently will be found where the same reservoir capacity serves several uses that are incidental to its designed single purpose intended use. Some of these are: use of water in the sediment pool for stock water, irrigation, recreation,

fish and wildlife production. In such cases, the benefits from all uses may be lumped and equated against all costs in the economic analysis.

G. Establishing the Economic Justification and Scale of a Multiple-Purpose Independent Structure.

A typical situation encountered in project formulation and evaluation has to do with the economic justification of a multiple-purpose structure. For example, suppose it has been determined that a multiple-purpose structure, with 2,000 acre-feet of flood prevention capacity and 1,000 acre-feet of storage for irrigation will meet the needs and objectives of the sponsors. It has been determined that average annual benefits will be $1,404 for flood prevention and $1,566 for irrigation, a total of $2,970. The average annual cost of the structure, including operation and maintenance, will be $2,550.

Specific costs assignable to irrigation amount to $100 annually but there are none for flood prevention. The Use of Facilities method to allocate joint costs assigns $1,633 to flood prevention, and $817, plus $100 specific costs, to irrigation. This analysis indicates that the following situation exists, (Step 1):

Purpose		Benefit	Cost	Benefit Cost Ratio
		(dollars)	(dollars)	
Flood Prevention		1,404	1,633	Unfavorable
Irrigation		1,566	917	Favorable
	Total	2,970	2,550	Favorable

According to this analysis flood prevention is not justified. Thus additional steps must be taken to assure economic feasibility of each purpose. This will require the use of an alternative method of cost allocation.

Economic feasibility can be determined by using an incremental analysis as illustrated by the two examples to follow. Any one of the purposes may be selected as the first increment. Also, this first increment need not necessarily be economically justified, but as illustrated below, must be justified for inclusion in the project when considered as the last increment.

In the next example irrigation is the first increment selected for analysis and the cost of irrigation as a single purpose would be $2,000 annually. Addition of flood prevention as a second increment would increase annual costs by only $550 but would provide $1,404 in annual benefits. This situation would exist, (Step 2):

Purpose	Increment	Benefit (dollars)	Cost (dollars)	Benefit Cost Ratio
Irrigation	First	1,566	2,000	Unfavorable
Flood Prevention	Second	1,404	550	Favorable
Total		2,970	2,550	Favorable

By this analysis irrigation has an unfavorable benefit to cost ratio even though the benefit cost ratios for flood prevention and the structure as a whole are favorable.

The analysis is carried further by treating flood prevention as the first increment and then adding irrigation. This analysis, produces these results, (Step 3):

Purpose	Increment	Benefit (dollars)	Cost (dollars)	Benefit Cost Ratio
Flood Prevention	First	1,404	1,912	Unfavorable
Irrigation	Second	1,566	638	Favorable
		2,970	2,550	Favorable

In this instance, flood prevention has an unfavorable ratio and that for irrigation as well as the whole structure is favorable. Note, however, that flood prevention in step 2 and irrigation in step 3 both have a favorable ratio as the last increment and that the overall benefit-cost ratio is favorable.

Of course, if both purposes were shown as being justified during the course of a given step in the analysis, steps 1, 2 and 3, further examination would not have been needed.

Steps 2 and 3, illustrate two significant points in the economic analysis of multiple-purpose independent structures. First, a purpose selected as the first increment for analysis, if not justifiable as that increment, must be justifiable when considered as the last increment if it is to be included in the project. Furthermore, if the structure or purpose is to be included in the project, the total benefits from all purposes must exceed the total costs of all purposes.

The procedure illustrated in steps 2 and 3 is applicable also to the addition of storage capacity for a single purpose. The process can be continued until the last increment costs more than it returns in benefits or until legal or physical limits on capacity are reached.

URBAN FLOODWATER DAMAGE

ECONOMIC EVALUATION

PROGRAM DESCRIPTION

The Urban Floodwater Damage Economic Evaluation program (URB1) will compute the average annual floodwater damages to urban properties. The program involves determining the percent damages to houses and contents of a number of representative types of houses or other buildings. These are located between cross sections by means of stationing along a common base line and by elevations at which damages begin. The damage to each house selected is computed based on its station, elevation, value and type of house with respect to a coefficient damage table. Included are adjustments for bridge head losses if not included in the hydrologic analysis.

The printout shows the average annual damages as computed for the area represented by each cross section, for each reach, and for each alternate.

INPUT REQUIREMENTS

Each of the input data card groupings in this version of the program has a control word so the order of input data is not rigid. This permits the computer to read a data card and to use it in accordance with its instructions. This minimizes the confusion that might arise from improper card sequence. In some cases where a group of cards must follow in a given order, the control word appears only on the first or header card. The sequence then usually is ended by a card bearing the control word "END TABLE". An example is the cross section data cards following the card headed "XSECTN" on the input formats.

Data limits are 100 cross sections, 30 bridges, 50 reaches, 10 coefficient damage tables, and 10 storms. There is no limit to the number of houses that can be included, or the number of alternatives that can be evaluated. The houses, bridges, and cross sections must be stationed along a common base line. The base line stationing may be either upstream or downstream, but the cross sections must be entered in order beginning with the most downstream section and proceeding upstream in sequence to the most upstream section. Since stationing for each alternate must be along a common base line, tributaries should not be included with the mainstem within an alternate.

Each tributary may be handled as a separate alternate.

Bridge data tables are entered in order of their station sequence with the cross section data tables.

It would be helpful if a simple sketch showing the approximate location of tributaries, valley sections, evaluation reaches, and structural measures in relation to the main stem and direction of flow were included with the input data. This may enable the ADP Unit personnel to resolve many questions without contacting the field.

DESCRIPTION OF INPUT DATA

Card columns 1-10 are used for control words which direct the operation of the program, card columns 11-70 are for the input data, and card columns 71-80 are for the users use in card identification.

CONTROL WORDS	FUNCTION
URB1	This card starts the operation and must be the first card in the input data deck.
TITLE	This will normally be the watershed name. 60 spaces are available for watershed identification information in card columns 11-70.
DETAIL	This control word is used to request printout of damages to each house by each evaluation flood. Its use is optional.
PCT-CHANCE	10 floods can be used. They must be listed in descending order of magnitude. Use card columns 21-70 by 10 column fields. Use a second card if more than 5 floods are specified.
REACH	These data cards give the cross section names included in each evaluation reach.

Columns	Data
11-15	Name of the reach. Alphabetic or numeric characters are allowed.
21-25, 31-35, 41-45, 51-55, and 61-65	List the cross sections included in the reach.

Use as many cards as needed. When cards covering all cross sections in the reach have been inserted, the "END TABLE" card is required.

CØF-DAMG — This is the control word for the damage coefficient tables. A maximum of 10 tables with 12 data sets per table are allowed.

First Card

Columns	Data
1-8	CØF-DAMG
11-15	House type - Alphabetic or numeric characters are allowed.

The next one to twelve cards as needed are:

1-10	Blank
11-20	Depth as stage. Do NOT enter elevation. The first data card should be zero stage.
21-30	Percent damage to the structure at this stage.
31-40	Percent damage to the contents at this stage.

The data cards must be followed by an "END TABLE" card.

HØUSE — This control word is used to enter data about each house or other building. Houses may be entered in any order.

Columns	Data
1-5	HØUSE
11-15	House type - Alphabetic or numeric characters are allowed. Must match one of the "CØF-DAMG" tables.
21-30	Station at the house.
31-40	Elevation of zero damage. Corresponds to zero stage in the "CØF-DAMG" table.
41-50	Dollar value of house structure.
51-60	Dollar value of the personal property in the house.
61-70	Elevation damage begins. This elevation should equal or exceed the elevation of zero damage. If left blank, it will be set equal to elevation zero damage.

The elevation of zero damage for each structure allows use of one coefficient damage table for any number of the same type structures even though they may be at different elevations. The elevation damage begins allows consideration of structures where damage may not occur until floodwater has reached an elevation higher than elevation of zero damage. For example, the elevation damage begins could be the basement window elevation, and elevation of zero damage could be the basement floor elevation.

CRØSS

This card corresponds to the update header card used in the ECON2 program. It provides additional information concerning the valley stationing of the cross section and the percent of the buildings sampled within the area represented by the cross section.

Columns	Data
1-5	CRØSS
11-15	Cross section name.
21-30	Elevation damage begins for non-structural damages. This data is optional and not used in the present version of URB1.
51-60	Valley stationing for the cross section.
61-70	The percent sample of houses within the cross sectional area used in the evaluation. If blank, program assumes 100% sample.

Elevation damage begins data is not needed for the cross section data since beginning damage elevations are included on the "HOUSE" data cards.

XSECTN

This is the header card for tabular information describing each cross section. The cross section identification name is entered in columns 11-15. This is the only data required on the header card for the URB1 program.

Up to 20 cross section data cards are allowed; use only as many as are needed.

Columns	Data
1-20	Blank
21-30	Elevation in feet.
31-40	Discharge in cfs corresponding to the elevation in column 21-30.
41-70	Not used by the URB1 program.

The data cards must be followed by an "END TABLE" card. The "XSECTN" tabular data may be from punched card output from the Water Surface Profile program. The data is also acceptable in the cross section table format used in the TR-20 program.

BRIDGE — This is the control word to enter Bridge data. The "BRIDGE" table must be located in the proper stationing sequence with the "XSECTN" tables.

Columns	Data
1-6	BRIDGE
11-15	Name of the Bridge - Alphabetic or numeric characters are allowed.
21-30	Station at the Bridge.

One to twenty data cards are allowed. Use only as many as are needed.

1-10	Blank
11-20	Elevation
21-30	Discharge in cfs.
31-40	Head loss at the Bridge.

The data cards must be followed by an "END TABLE" card. Make sure "FLOW-FREQ" data is entered for each "BRIDGE" table.

FLØW-FREQ — The data on this card relates the discharges shown in the "XSECTN" data cards to their frequencies set up in the "PCT-CHANCE" cards. When more than 5 floods are used, 2 cards will be needed for each cross section and each bridge. The order of floods must be the same as in "PCT-CHANCE".

Columns	Data
1-9	FLØW-FREQ
11-15	Name of the cross section or bridge - Alphabetic or numeric characters are allowed.
21-70 by 10 col. fields	Discharges are shown in cfs with decimals.

This input data may be obtained from punched card output from the TR-20 Hydrology program.

CØMPUTE — This control word accompanies the Alternate Title card as instruction for the machine to start computing data.

Columns	Data
1-7	CØMPUTE
21-25	The name of the beginning reach.
31-35	Name of the last reach to compute.

CØNTINUE — This card may be used in the computation for an alternate when the reaches are separated by an unchanged reach. In this case, the compute card will show the first set of reaches to be computed. The "CØNTINUE" card will show the next group. The machine will not recompute the intervening reaches. As many "CØNTINUE" cards as needed may be used for each alternate.

Columns	Data
1-8	CØNTINUE
21-25	The name of the beginning reach.
31-35	The name of the last reach to compute.

ALT-TITLE — This card is for any descriptive title. The title will be printed out the same as it is inserted here, up to a maximum of 60 spaces, columns 11-70. The card is required.

END JØB — This card tells the computer the job is finished. It is the last card in the input data deck.

Complete URB1 jobs may be stacked together as batched jobs. Each job will start as it reads the URB1 card, and end as it reads the "END JØB" card.

SAMPLE INPUT AND OUTPUT

An example of the input data for the URB1 program and of the printed output using the "DETAIL" option is shown on the following pages.

SCS-MGT-1
REV. 1-72

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

URB1 GENERAL INPUT DATA

SUNNY BROOK W'SHED BY J. DOE CHECKED _____ DATE 1-7-75
(JOB OR PROJECT)

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
Control Word	Current Date						Card Ident.
URB1	01/07/75						1
TITLE	SUNNY BROOK, ANYPLACE, U.S.A.						2
DETAIL							3
		1 or 6	2 or 7	3 or 8	4 or 9	5 or 10	
PCT-CHANCE		1.	2.	4.	10.	20.	4
PCT-CHANCE		50.	100.	—	—	—	5
		From Reach	Thru Reach				
COMPUTE		7	7				81
ALT-TITLE	SUNNY BROOK WATERSHED ALT. 1 - PROJECT (JAN. 1975)						82
		From Reach	Thru Reach				
~~CONTINUE~~							
~~CONTINUE~~							
END JOB							83

SCS-MGT-1
REV. 1-72

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

URB1 EVALUATION REACH DATA

SUNNY BROOK W'SHED (JOB OR PROJECT) BY J. DOE CHECKED _____ DATE 1-7-75

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
Control Word	Name	Section Name	Section Name	Section Name	Section Name	Section Name	Card Ident.
REACH	7	10	9	8	7		6
END TABLE							7
REACH							
END TABLE							
REACH							
END TABLE							
REACH							
END TABLE							
REACH							
END TABLE							

PAGE 2 OF 11

USDA SCS HYATTSVILLE MD 1972

SCS-MGT-1
REV. 1-72

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

URB1 DAMAGE COEFFICIENT DATA

SUNNY BROOK W'SHED (JOB OR PROJECT) BY J. DOE CHECKED _____ DATE 1-7-75

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
Control Word	Name Type						Card Ident.
CØF-DAMG	AGY						8
	Depth	% Structure Damage	% Content Damage				
	0.	0.	0.				9
	1.	0.	50.				10
	2.	0.	100.				11
	3.	0.	100.				12
	4.	0.	105.				13
END TABLE							14

USDA SCS-HYATTSVILLE MD. 1972

SCS-MGT-1
REV. 1-72

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

URB1 DAMAGE COEFFICIENT DATA

SUNNY BROOK WATERSHED (JOB OR PROJECT) BY J. DOE CHECKED _____ DATE 1-7-75

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
Control Word	Name Type						Card Ident.
CØF-DAMG	BRK						15
	Depth	% Structure Damage	% Content Damage				
	0.	0.	0.				16
	1.	0.	50.				17
	2.	0.	90.				18
	3.	0.	100.				19
	4.	0.	110.				20
END TABLE							21

PAGE 4 OF 11

USDA SCS-M-1 REV. 1-72

SCS-MGT-1
REV. 1-72

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

URB1 BUILDING DATA

SUNNY BROOK W'SHED (JOB OR PROJECT) BY J. DOE CHECKED _____ DATE 1-7-75

1-10	11-20		21-30	31-40	41-50	51-60	61-70	71-80
Control Word	Name Type		Valley Stationing	Elev. Zero Damage	House Value	Content Value	Elev. Damage Begins	Card Ident.
HOUSE	AGY		9730.	1250.6	12000.	12000.	1250.7	22
HOUSE	AGY		9730.	1249.6	9000.	9000.	1249.7	23
HOUSE	AGY		9730.	1248.5	15000.	15000.	1248.6	24
HOUSE	AGY		9730.	1249.1	12000.	12000.	1249.2	25
HOUSE	AGY		9770.	1245.6	8000.	8000.	1245.7	26
HOUSE	AGY		9770.	1245.1	8000.	8000.	1245.2	27
HOUSE	AGY		10450.	1234.2	3950.	3950.	1234.2	28
HOUSE	BRK		11810.	1205.9	233600	233600.	1206.	29
HOUSE	BRK		10130.	1238.4	38900.	38900.	1238.5	30
HOUSE	BRK		10830.	1223.	14840.	14840.	1223.1	31
HOUSE								
HOUSE								
HOUSE								
HOUSE								
HOUSE								
HOUSE								
HOUSE								
HOUSE								
HOUSE								
HOUSE								
HOUSE								
HOUSE								

USGA SCS-HYATTSVILLE MD. 1972

SCS-MGT-1
REV. 1-72

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

URB1 UPDATE HEADER CARD

CROSS SECTION DATA

SUNNY BROOK W'SHED BY J DOE CHECKED _____ DATE 1-7-75
(JOB OR PROJECT)

1-10	11-20		21-30	31-40	41-50	51-60	61-70	71-80
Control Word	Name		Elev. Damage Begins			Valley Stationing	Percent Sample	Card Ident.
CRØSS	10		—			11810.	—	32
CRØSS	9		—			11090.	—	33
CRØSS	8		—			10750.	—	34
CRØSS	7		—			9750.	—	35
~~CRØSS~~								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
~~CRØSS~~								

PAGE 6 OF 11

SCS-232
8-68

CROSS SECTION DATA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WATERSHED SUNNY BROOK TECHNICIAN J. DOE DATE 1-7-75

Control Word	Cross Section Name	Options 1/ 2/ 3/	Drainage Area Sq. Miles	Curve Number II	Time of Concentration, Hours	Elev. Damage Begins, Ft.	Ratio FP Area/Width	Card Ident.
XSECTN	10					1202.1	11810.	36

1/ Detail Printout
2/ Summary Printout
3/ Update Header Card Only

	Elevation, Feet	Discharge, cfs	Cross - Sectional Area, Sq. Ft.	Area Flooded or Floodplain Width	Stage - Damage, Dollars	Card Ident.
	1199.	0.0	0.0	0.0	0.0	37
	1202.1	300	139.11	0.		38
	1203.	480	411.61	6.		39
	1204.	640	1078.64	10.		40
	1205.	800	1996.66	13.		41
	1206.	990.	3128.42	15.5		42
	1207.	1190.	4475.9	18.5		43
	1208.	1480.	6048.1	21.2		44
END TABLE						45

Key Punch Operator: This Form Set Up For 10 - Column Skip With Exceptions As Noted. Left Justify Data In Open Fields.

USDA-SCS-HYATTSVILLE, MD 1968

SCS-252
9-68

CROSS SECTION DATA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WATERSHED SUNNY BROOK TECHNICIAN J. DOE DATE 1-1-75

Control Word	Cross Section Name	Options 1/ 2/ 3/	Drainage Area Sq. Miles	Curve Number II	Time of Concentration, Hours	Elev. Damage Begins, Ft.	Ratio FP Area/Width	Card Ident.
XSECTN	9		5.54			1219.5	11090.	46

1/ Detail Printout
2/ Summary Printout
3/ Update Header Card Only

	Elevation, Feet	Discharge, cfs	Cross - Sectional Area, Sq. Ft.	Area Flooded or Floodplain Width	Stage - Damage, Dollars	Card Ident.
	1212.	0.0	0.0	0.0	0.0	47
	1219.5	1020.	140.	0.		48
	1221.	1190	4270.	7.5		49
	1222.	1410.	5215	8.8		50
END TABLE						51

Key Punch Operator: This Form Set Up For 10 - Column Skip With Exceptions As Noted. Left Justify Data In Open Fields.

USCA-SCS-HYATTS, LLC. MD 1968

Page 8 of 11

SCS-282
8-68

CROSS SECTION DATA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WATERSHED *SUNNY BROOK* TECHNICIAN *J. DOE* DATE *1-7-75*

Control Word	Cross Section Name	Options 1/ 2/ 3/	Drainage Area Sq. Miles	Curve Number II	Time of Concentration, Hours	Elev. Damage Begins, Ft.	Ratio FP Area/Width	Card Ident.
XSECTN	8		5.38			1222.5	10750.	52

1/ Detail Printout
2/ Summary Printout
3/ Update Header Card Only

	Elevation, Feet	Discharge, cfs	Cross - Sectional Area, Sq. Ft.	Area Flooded or Floodplain Width	Stage - Damage, Dollars	Card Ident.
	1219.	0.0	0.0	0.0	0.0	53
	1222.5	850.	87.44	0.		54
	1223.	910.	102.4	.1		55
	1224.	1000.	155.29	.2		56
	1225.	1040.	234.69	.3		57
	1226.	1080.	408.77	.7		58
	1227.	1180.	608.4	.8		59
	1228.	1390.	821.29	.9		60
	1229.	1620.	1065.47	1.		61
END TABLE						62

Key Punch Operator: This Form Set Up For 10 - Column Skip With Exceptions As Noted. Left Justify Data In Open Fields.

USDA-SCS-HYATTSVILLE, MD 1969

SCS-252
8-68

CROSS SECTION DATA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WATERSHED SUNNY BROOK TECHNICIAN J. DOE DATE 1-1-75

Control Word	Cross Section Name	Options 1/ 2/ 3/	Drainage Area Sq. Miles	Curve Number II	Time of Concentration, Hours	Elev. Damage Begins, Ft.	Ratio FP Area/Width	Card Ident.
XSECTN	7		5.22			1246.5	9750.	63

1/ Detail Printout
2/ Summary Printout
3/ Update Header Card Only

	Elevation, Feet	Discharge, cfs	Cross - Sectional Area, Sq. Ft.	Area Flooded or Floodplain Width	Stage - Damage, Dollars	Card Ident.
	1239.	0.0	0.0	0.0	0.0	64
	1246.5	1020.	411.76	0.		65
	1247.	1050.	512.16	1.8		66
	1248.	1110.	757.18	2.7		67
	1249.	1190.	1073.72	3.2		68
	1250.	1280.	1422.17	3.3		69
	1251.	1400.	1780.87	3.5		70
	1252.	1600.	2147.44	3.6		71
END TABLE						72

Key Punch Operator: This Form Set Up For 10 - Column Skip With Exceptions As Noted. Left Justify Data In Open Fields.

USDA-SCS-HYATTSVILLE, MD 1968

SCS-283
8-68

FLOW–FREQUENCY DATA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WATERSHED Sunny Brook TECHNICIAN J. Doe DATE 1-7-75

Control Word	Cross Section Name		Discharge, cfs Q_1 or Q_6	Q_2 or Q_7	Q_3 or Q_8	Q_4 or Q_9	Q_5 or Q_{10}	Card Ident.
FLOW-FREQ	10		1400.	1300.	1110.	830.	615.	73
FLOW-FREQ	10		390.	265.	—	—	—	74
FLOW-FREQ	9		1400.	1300.	1110.	830.	615.	75
FLOW-FREQ	9		390.	265.	—	—	—	76
FLOW-FREQ	8		1400.	1300.	1110.	830.	615.	77
FLOW-FREQ	8		390.	265.	—	—	—	78
FLOW-FREQ	7		1400.	1300.	1110.	830.	615.	79
FLOW-FREQ	7		390.	265.	—	—	—	80
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								
FLOW-FREQ								

Key Punch Operator: This Form Set Up For 10 - Column Skip With Exceptions As Noted. Left Justify Data In Open Fields.

USDA-SCS-HYATTSVILLE, MD. 1968

Page 11 of 11

```
*********************     80-80 LISTING OF INPUT DATA     *********************

URB1                                                                            01
TITLE      SUNNY BROOK, ANYPLACE, U.S.A.                                        02
DETAIL                                                                          03
PCT-CHANCE            1.        2.        4.        10.       20.             04
PCT-CHANCE            50.       100.                                            05
REACH      7          10        9         8         7                         06
END TABLE                                                                       07
COF-DAMAGEAGY                                                                   08
           0.         0.        0.                                              09
           1.         0.        50.                                             10
           2.         0.        100.                                            11
           3.         0.        100.                                            12
           4.         0.        105.                                            13
END TABLE                                                                       14
COF-DAMAGEBRK                                                                   15
           0.         0.        0.                                              16
           1.         0.        50.                                             17
           2.         0.        90.                                             18
           3.         0.        100.                                            19
           4.         0.        110.                                            20
END TABLE                                                                       21
HOUSE      AGY        9730.     1250.6    12000.    12000.    1250.7            22
HOUSE      AGY        9730.     1249.6    9000.     9000.     1249.7            23
HOUSE      AGY        9730.     1248.5    15000.    15000.    1248.6            24
HOUSE      AGY        9730.     1249.1    12000.    12000.    1249.2            25
HOUSE      AGY        9770.     1245.6    8000.     8000.     1245.7            26
HOUSE      AGY        9770.     1245.1    8000.     8000.     1245.2            27
HOUSE      AGY        10450.    1234.2    3950.     3950.     1234.2            28
HOUSE      BRK        11810.    1205.9    233600.   233600.   1206.             29
HOUSE      BRK        10130.    1238.4    38900.    38900.    1238.5            30
HOUSE      BRK        10830.    1223.     14840.    14840.    1223.1            31
CROSS      10                                        11810.                      32
CROSS      9                                         11090.                      33
CROSS      8                                         10750.                      34
CROSS      7                                         9750.                       35
```

```
XSECTN    10        5.66                          1202.1    11810.        36
                    1199.     0.0       0.0       0.0       0.C           37
                    1202.1    300.      139.11    0.                      38
                    1203.     480.      411.61    6.                      39
                    1204.     640.      1078.64   10.                     40
                    1205.     800.      1996.66   13.                     41
                    1206.     990.      3128.42   15.5                    42
                    1207.     1190.     4475.9    18.5                    43
                    1208.     1480.     6048.1    21.2                    44
END TABLE                                                                 45
XSECTN    9     1   5.54                          1219.5    11090.        46
                    1212.     0.        0.        0.        0.            47
                    1219.5    1020.     140.      0.                      48
                    1221.     1190.     4270.     7.5                     49
                    1222.     1410.     5215.     8.8                     50
END TABLE                                                                 51
XSECTN    8     1   5.38                          1222.5    10750.        52
                    1219.     0.        0.        0.        0.            53
                    1222.5    850.      87.44     0.                      54
                    1223.     910.      102.4     .1                      55
                    1224.     1000.     155.29    .2                      56
                    1225.     1040.     234.69    .3                      57
                    1226.     1080.     408.77    .7                      58
                    1227.     1180.     608.4     .8                      59
                    1228.     1390.     821.29    .9                      60
                    1229.     1620.     1065.47   1.                      61
END TABLE                                                                 62
XSECTN    7     1   5.22                          1246.5    9750.         63
                    1239.     0.        0.        0.        0.            64
                    1246.5    1020.     411.76    0.                      65
                    1247.     1050.     512.16    1.8                     66
                    1248.     1110.     757.18    2.7                     67
                    1249.     1190.     1073.72   3.2                     68
                    1250.     1280.     1422.17   3.3                     69
                    1251.     1400.     1780.87   3.5                     70
                    1252.     1600.     2147.44   3.6                     71
END TABLE                                                                 72
FLOW-FREQ 10        1400.     1300.     1110.     830.      615.          73
FLOW-FREQ 10        390.      265.                                        74
FLOW-FREQ 9         1400.     1300.     1110.     830.      615.          75
FLOW-FREQ 9         390.      265.                                        76
FLOW-FREQ 8         1400.     1300.     1110.     830.      615.          77
FLOW-FREQ 8         390.      265.                                        78
FLOW-FREQ 7         1400.     1300.     1110.     830.      615.          79
FLOW-FREQ 7         390.      265.                                        80
COMPUTE             7         7                                           81
ALT-TITLE SUNNY BROOK WATERSHED ALT. 1 - PROJECT (JAN. 1975)              82
END JOB                                                                   83
```

```
RETURNED FROM READ5

 STORM ELEVATION AT KXSEC
KXSEC  STATION ELEVATION
   1 11810.00 ELEV   1207.72   1207.38   1206.60   1205.16   1203.84   1202.55   1201.74
          DISCHARGE   1400.0    1300.0    1110.0     830.0     615.0     390.0     265.0
   2 11090.00 ELEV   1221.95   1221.50   1220.29   1218.10   1216.52   1214.87   1213.95
          DISCHARGE   1400.0    1300.0    1110.0     830.0     615.0     390.0     265.0
   3 10750.00 ELEV   1228.04   1227.57   1226.30   1222.42   1221.53   1220.61   1220.09
          DISCHARGE   1400.0    1300.0    1110.0     830.0     615.0     390.0     265.0
   4  9750.00 ELEV   1251.00   1250.17   1248.00   1245.10   1243.52   1241.87   1240.95
          DISCHARGE   1400.0    1300.0    1110.0     830.0     615.0     390.0     265.0

RETURNED FROM URBAN
NERR = 0, KXSEC =  4, NRCH =  1, NSTORM =  7, NBRID =  0, NCOEF =  2, NJOB = 0, NTYPE =  1

 RETURNED FROM SORT
```

LISTING OF PROPERTIES DAMAGED FOR ALTERNATE 1

LINE ONE REPEATS HOUSE CARDS

THE NEXT LINES OF THE SET ARE

	STRUCT DAMAGE	ACC. XSECTN DAMAGE	STRUCT PLUS CONTENT	SEQ HOUSE NUMBER	SEQ STORM NUMBER	UPSTR XSECTN NUMBER	
AGY	9770.0	1245.6	8000.0	8000.0		1245.7	26
	0.0	8000.00	8000.00	5	1	3	
	0.0	8000.00	8000.00	5	2	3	
	0.0	7864.25	7864.25	5	3	3	
AGY	9770.0	1245.1	8000.0	8000.0		1245.2	27
	0.0	16000.00	8000.00	6	1	3	
	0.0	16000.00	8000.00	6	2	3	
	0.0	15864.25	8000.00	6	3	3	
AGY	10450.0	1234.2	3950.0	3950.0		1234.2	28
	0.0	17442.19	1442.19	7	1	3	
	0.0	16295.57	295.57	7	2	3	
BRK	11810.0	1205.9	233600.0	233600.0		1206.0	29
	0.0	193814.69	193814.69	8	1	1	
	0.0	161580.81	161580.81	8	2	1	
	0.0	81754.25	81754.25	8	3	1	
BRK	10130.0	1238.4	38900.0	38900.0		1238.5	30
	0.0	59751.63	42309.44	9	1	3	
	0.0	55896.45	39600.88	9	2	3	
	0.0	40822.55	24958.30	9	3	3	
BRK	10830.0	1223.0	14840.0	14840.0		1223.1	31
	0.0	15746.12	15746.12	10	1	2	
	0.0	15051.58	15051.58	10	2	2	
	0.0	12682.11	12682.11	10	3	2	

RETURNED FROM SUBROUTINE HOUSE

URB1 XEQ 03/10/75
REV 03/06/73

TITLE SUNNY BROOK, ANYPLACE, U.S.A. 02
ALT-TITLE SUNNY BROOK WATERSHED ALT. 1 - PROJECT (JAN. 1975) 82
URBAN DAMAGE
FOR ALTERNATE 1

CROSS SECTION 10 TO CROSS SECTION ~~10~~ 9

STORM FREQUENCY	STORM DISCHARGE	BUILDINGS FLOODED	TOTAL DAMAGE
1.00	1400.00	1	193814.69
2.00	1300.00	1	161580.81
4.00	1110.00	1	81754.25
10.00	830.00	0	0.0
20.00	615.00	0	0.0
50.00	390.00	0	0.0
100.00	265.00	0	0.0

AVERAGE ANNUAL DAMAGE = 7168.64

CROSS SECTION ~~10~~ 9 TO CROSS SECTION ~~9~~ 8

STORM FREQUENCY	STORM DISCHARGE	BUILDINGS FLOODED	TOTAL DAMAGE
1.00	1400.00	1	15746.12
2.00	1300.00	1	15051.58
4.00	1110.00	1	12682.11
10.00	830.00	0	0.0
20.00	615.00	0	0.0
50.00	390.00	0	0.0
100.00	265.00	0	0.0

AVERAGE ANNUAL DAMAGE = 783.87

URB1 XEQ 03/10/75
REV 03/06/73

TITLE SUNNY BROOK, ANYPLACE, U.S.A. 02
ALT-TITLE SUNNY BROOK WATERSHED ALT. 1 - PROJECT (JAN. 1975) 82
URBAN DAMAGE
FOR ALTERNATE 1

CROSS SECTION 9 TO CROSS SECTION 8

STORM FREQUENCY	STORM DISCHARGE	BUILDINGS FLOODED	TOTAL DAMAGE
1.00	1400.00	4	59751.63
2.00	1300.00	4	55896.45
4.00	1110.00	3	40822.55
10.00	830.00	0	0.0
20.00	615.00	0	0.0
50.00	390.00	0	0.0
100.00	265.00	0	0.0

AVERAGE ANNUAL DAMAGE = 2772.82

URB1 XEQ 03/10/75
REV 03/06/73

TITLE SUNNY BROOK, ANYPLACE, U.S.A. 02
ALT-TITLE SUNNY BROOK WATERSHED ALT. 1 - PROJECT (JAN. 1975) 82
URBAN DAMAGE
FOR ALTERNATE 1

REACH 7

STORM FREQUENCY	BUILDINGS FLOODED	TOTAL DAMAGE
1.	6	269312.38
2.	6	232528.81
4.	5	135258.81
10.	0	0.0
20.	0	0.0
50.	0	0.0
100.	0	0.0

AVERAGE ANNUAL DAMAGE = 10725.32

CLASS INTERVAL OF PROPERTY VALUE	NO. OF HOUSES	AVERAGE ANNUAL DAMAGE PROPERTY	CONTENTS	TOTAL
0. THRU 2500.	0	0.0	0.0	0.0
2500. THRU 5000.	1	0.0	23.40	23.40
5000. THRU 7500.	0	0.0	0.0	0.0
7500. THRU 10000.	2	0.0	984.22	984.22
10000. THRU 12500.	0	0.0	0.0	0.0
12500. THRU 15000.	1	0.0	783.87	783.87
15000. THRU 20000.	0	0.0	0.0	0.0
20000. THRU 25000.	0	0.0	0.0	0.0
25000. THRU 30000.	0	0.0	0.0	0.0
30000. THRU 40000.	1	0.0	1765.20	1765.20
40000. THRU 50000.	0	0.0	0.0	0.0
50000. THRU 75000.	0	0.0	0.0	0.0
75000. THRU 100000.	0	0.0	0.0	0.0
OVER 100000.	1	0.0	7168.64	7168.64

TOTAL PROPERTY VALUE= 307290.00

TOTAL CONTENT VALUE= 307290.00

URB1 XEQ 03/10/75
REV 03/06/73

TITLE SUNNY BROOK, ANYPLACE, U.S.A. 02
ALT-TITLE SUNNY BROOK WATERSHED ALT. 1 - PROJECT (JAN. 1975) 82
URBAN DAMAGE
FOR ALTERNATE 1

ALTERNATE TOTAL

STORM FREQUENCY	BUILDINGS FLOODED	TOTAL DAMAGE
1.	6	269312.38
2.	6	232528.81
4.	5	135258.81
10.	0	0.0
20.	0	0.0
50.	0	0.0
100.	0	0.0

AVERAGE ANNUAL DAMAGE = 10725.32

CLASS INTERVAL OF PROPERTY VALUE	NO. OF HOUSES	AVERAGE ANNUAL DAMAGE PROPERTY	CONTENTS	TOTAL
0. THRU 2500.	0	0.0	0.0	0.0
2500. THRU 5000.	1	0.0	23.40	23.40
5000. THRU 7500.	0	0.0	0.0	0.0
7500. THRU 10000.	2	0.0	984.22	984.22
10000. THRU 12500.	0	0.0	0.0	0.0
12500. THRU 15000.	1	0.0	783.87	783.87
15000. THRU 20000.	0	0.0	0.0	0.0
20000. THRU 25000.	0	0.0	0.0	0.0
25000. THRU 30000.	0	0.0	0.0	0.0
30000. THRU 40000.	1	0.0	1765.20	1765.20
40000. THRU 50000.	0	0.0	0.0	0.0
50000. THRU 75000.	0	0.0	0.0	0.0
75000. THRU 100000.	0	0.0	0.0	0.0
OVER 100000.	1	0.0	7168.64	7168.64

TOTAL PROPERTY VALUE= 307290.00

TOTAL CONTENT VALUE= 307290.00

RETURNED FROM READ5

```
URB1  XEQ 03/10/75
      REV 03/06/73

END OF JOB CARD HIT FOR JOB NUMBER  1
```

SCS-MGT-1
REV. 1-72

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

URB1 GENERAL INPUT DATA

_____ _____ BY _____ CHECKED _____ DATE _____
(JOB OR PROJECT)

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0
Control Word	Current Date						Card Ident.
URB1							
TITLE							
DETAIL							
		1 or 6	2 or 7	3 or 8	4 or 9	5 or 10	
PCT-CHANCE							
PCT-CHANCE							
		From Reach	Thru Reach				
CØMPUTE							
ALT-TITLE							
		From Reach	Thru Reach				
CØNTINUE							
CØNTINUE							
END JØB							

PAGE _____ OF _____

USDA-SCS-HYATTSVILLE, MD. 1972

SCS-MGT-1
REV. 1-72

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

URB1 EVALUATION REACH DATA

_____ BY _____ CHECKED _____ DATE _____
(JOB OR PROJECT)

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0
Control Word	Name	Section Name	Section Name	Section Name	Section Name	Section Name	Card Ident.
REACH							
END TABLE							
REACH							
END TABLE							
REACH							
END TABLE							
REACH							
END TABLE							
REACH							
END TABLE							

PAGE _____ OF _____

SCS-MGT-1
REV. 1-72

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

URB1 DAMAGE COEFFICIENT DATA

_____ BY _____ CHECKED _____ DATE _____
(JOB OR PROJECT)

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
Control Word	Name Type						Card Ident.
CØF-DAMG							
	Depth	% Structure Damage	% Content Damage				
END TABLE							

PAGE _____ OF _____

SCS-MGT-1
REV. 1-72

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

URB1 BUILDING DATA

_____ BY _____ CHECKED _____ DATE _____
(JOB OR PROJECT)

1-10	11-20		21-30	31-40	41-50	51-60	61-70	71-80
Control Word	Name Type		Valley Stationing	Elev. Zero Damage	House Value	Content Value	Elev. Damage Begins	Card Ident.
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								
HØUSE								

PAGE _____ OF _____

USDA-SCS-HYATTSVILLE, MD. 1972

SCS-MGT-1
REV. 1-72

URB1 UPDATE HEADER CARD
CROSS SECTION DATA

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

_____ BY _____ CHECKED _____ DATE _____
(JOB OR PROJECT)

1-10	11-20		21-30	31-40	41-50	51-60	61-70	71-80
Control Word	Name		Elev. Damage Begins			Valley Stationing	Percent Sample	Card Ident.
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								
CRØSS								

PAGE _____ OF _____

USDA-SCS-HYATTSVILLE, MD. 1972

The control word is always punched in Columns 1-10 as indicated.

CONTROL WORD

1. XSECTN — The information header card for hydraulic data table for cross sections.

Cols 11-15	Cross section name. Name can be any alpha-numeric designation, i.e., A-22, 293, or 14B. The program ignores blanks.
Col 16	An option to get detail printout by storms for this cross section.
Col 18	An option to get only a summary printout for this cross section.
Col 20	An option to read in only this header card (to update the information or when the hydraulic table is read in with the format for the project formulation-hydrology program).

Note: For options in Cols 16, 18, and 20 use a '1', otherwise leave blank.

Cols 21-50 by 10's	These fields contain information not used by the economics program.
Cols 51-60	The elevation, or stage, at which damage begins. A decimal is required.
Cols 61-70	Ratio of floodplain area to width. Can be used to modify area flooded values in the table. If left blank the program assumes 1.0. A decimal is required.

Data Cards

Cols 21-30	Elevation, or stage, in feet. Decimal is required.
Cols 31-40	The discharge in cfs. Decimal is required.
Cols 41-50	Cross-sectional area in square feet. Not required for economics program. Decimal is required.
Cols 51-60	Acres flooded or floodplain width. May be modified by a constant in Cols 61-70 of 'XSECTN' header card or in Cols 21-30 of 'ADD ACRES' card. Decimal is required.
Cols 61-70	Actual dollar damage values. Normally would be used only in an urban reach. Is not associated with acres inundated. A decimal is required.
Cols 71-80	Reserved for identification by the user. Is not examined by the program.

LINE OUT ANY UNUSED CARDS ON THE FORM

(JOB OR PROJECT)

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
Control Word	Name	Valley Stationing					Card Ident.
BRIDGE							
	Upstream Elevation	Discharge	Bridge Headloss				
END TABLE							

PAGE _____ OF _____

USDA-SCS-HYATTSVILLE, MD. 1972

FLOW-FREQ						
FLOW-FREQ						
FLOW-FREQ						
FLOW-FREQ						
FLOW-FREQ						

USDA-SCS-HYATTSVILLE, MD. 1968

Key Punch Operator: This Form Set Up For 10 - Column Skip With Exceptions As Noted. Left Justify Data In Open Fields.

Page ____ of ____

e control word is always punched in Columns 1-10 as indicated.

NTROL WORD

FLOW-FREQ	Contains the cross section discharge data for the frequency method. Two cards required per cross section if more than five floods in the series.
Cols 11-15	The cross section name. The name can be any alpha-numeric designation, i.e., A-22, 293, or 14B. The program ignores blanks.
Cols 21-70 by 10's	The discharges in cfs for this cross section that are associated with the flood frequencies read in on the PCT-CHANCE card(s). Decimals are required.
Cols 71-80	Reserved for identification by the user. Is not examined by the program.

LINE OUT ANY UNUSED CARDS ON THE FORM

CHAPTER 3

FLOODWATER DAMAGES AND BENEFITS

This chapter describes the appraisal of floodwater damages and benefits. It first outlines the evaluation background. Then it describes general methods of determining average annual floodwater damage. It discusses considerations in appraising most of the different types of floodwater damage such as agricultural, urban residential, industrial and commercial; and transportation. The final sections of the chapter consider flood prevention benefit-cost evaluation.

For the most part the discussion is confined to the application of economic principles to the problem at hand, and general methods of accumulating and analyzing data for evaluation purposes. No attempt is made to prescribe step-by-step procedural details. The diversity of conditions found would cause such an approach for nation-wide application to be more harmful than beneficial.

I. GENERAL CONSIDERATIONS IN DAMAGE APPRAISAL

Damage appraisal for project evaluation involves a comparison of the damage that can be expected without the project and that which will occur after the project is installed. Proper appraisal requires a projection of physical and economic conditions during the life of the project. The present condition is merely a convenient benchmark from which to estimate future conditions without and with the project. This projection into the future is most difficult.

A few of the problems often encountered in making these projections are outlined below. (1) Perhaps sediment is filling the channel so that if nothing is done flooding will become more severe. It may become so serious that cultivation of most, or all, of the flood plain will be abandoned. (2) On the other hand, there may be channel degradation or bank cutting which will increase the size of the channel if nothing is done. Then flooding can be expected to become less frequent and severe, or land may be lost from production. When either of these conditions exist, the economist is dependent upon both the geologist and hydrologist for projections of the physical conditions. (3) Agricultural trends must be considered. It may be that the type of agriculture is changing and is affecting the land use pattern. Technological progress in agriculture is causing marked increases in yields. The economist must consider how these advances will affect crop and pasture yields during the life of the project. Even though the project were not installed, technological progress can be expected. Changes brought about by improved technology should not be confused with those caused by recovery from land damage as described in Chapter 5. They also should be kept separate from yield increases that arise from the fact that greater advantage can be taken of technological improvement if flood risks are reduced. Increases of this type

are described in Chapter 4. (4) Non-agricultural values are increasing constantly. They may take the form of residential or industrial developments encroaching upon the flood plain. Or they may arise merely from higher values attached to existing development. For example, the constantly rising standard of living has resulted in the average residence containing appliances that were unknown 20 years ago.

Many different methods may be used in making projections of future conditions. The method used will depend upon the given situation. Mere extrapolation of existing trends generally is not sufficient. The economist will need to gather and evaluate sufficient background data to form a basis for sound projections.

II. MAJOR METHODS OF CALCULATING AVERAGE ANNUAL DAMAGE

The measurement of floodwater damages and the benefit from reduction of damage usually is done by one of four methods. Each of the methods may be specially applicable to particular situations. This section describes each briefly.

A. Frequency Method

The frequency method used in flood damage appraisal involves the establishment of relationships between the physical and economic flood characteristics and the probable frequency of flood occurrence.

The physical appraisal involves establishing the relationships of the physical characteristics of floods to frequency of their occurrence. These associations, generally expressed by means of graphs, include the following:

1. Runoff related to frequency of occurrence -- obtained either through conversion of rainfall to runoff, or from runoff as measured by stream gages.

2. Runoff versus discharge (cfs).

*3. Discharge (cfs) versus frequency.

*4. Discharge (cfs) versus flood stage.

5. Flood stage versus area flooded.

The economic appraisal involves establishing and relating monetary values to the physical flood characteristics and to frequency of flood occurrences. These associations, generally expressed by means of graphs, include the following, which are developed as needed to evaluate different types of floodwater damages.

1. Area flooded versus damage.

*2. Flood stage versus damage.

3. Discharge versus damage.

*4. Damage versus frequency of occurrence.

*Samples of these graphs are illustrated in Figures 3.1 through 3.4. Such graphs make possible the computation of average annual flood damages for the stream reach covered by the graph.

1. Stage-Damage

Flood damage surveys provide the basis for formulating this curve (Figure 3.1). The height of an experienced flood is used as the base point from which stages of other experienced or potential floods are referenced. Damages are appraised for sufficient stages to define the shape of the curve adequately. Columns 1 and 2, table 3.1, illustrate this phase of the frequency method.

2. Stage-discharge and discharge-frequency

Details of the construction of stage-discharge and discharge-frequency graphs are given in Chapters 14 and 18, respectively, of the Hydrology Handbook - for watershed planning.

Figures 3.2 and 3.3 and columns 3 and 4 of Table 3.1 indicate application of these data in the procedure.

The damage-frequency curve, figure 3.4, is drawn through the plotted values of corresponding damage and frequency. The values used in producing this graph are shown in Table 3.1. Average annual damage is determined from the damage frequency curve by the following calculations:

a. Planimeter in square inches the area enclosed by the curve.

b. Determine the product of the values of the abscissa and the ordinate at the point one inch from the point of origin. This value determined from figure 3.4 is obtained as follows: abscissa one percent, ordinate $100,000, giving a product of $1,000.

c. Product of the total square inches measured in a. (13.39) and unit value per square inch determined in b. ($1,000) is equal to average annual damage ($13,390).

Table 3.1 - Reach No. 4 _____ Creek
Damages Resulting from Floods of Different Sizes and Frequencies

Flood stage in relation to flood of 6/15/45 (Feet)	Damage (Dollars)	Peak Discharge (c.f.s.)	Chance of Occurrence 1/ (Percent)
+ 2	1,000,000	4,200	Less than 1
+ 1	720,000	3,450	Less than 1
6/15/45	410,000	2,800	1.4
- 1	110,000	2,000	3.2
- 2	10,000	1,500	6.0
- 3	0	1,200	7.5

1/ Frequency of occurrence may be expressed in several ways, each of which may be converted to the other. The term used herein should be interpreted to mean the percent chance of a given peak discharge being equalled or exceeded in any one year.

The frequency series offers an approach to computing average annual damages by weighting the effect of all floods without estimating losses separately for each flood in a long series of events, thereby providing an estimate at a saving of work over the historical series method. Thus, when conditions are suitable for its use, such as when damageable values can be restored between floods as in residential areas, it is the preferable method.

The seasonal distribution of floods must be taken into account when evaluating crop and pasture damages. This is necessary because of the difference in flood damage resulting from given flood stages during different periods of plant growth. The relative frequency of flooding by seasons or months furnishes the basis for making the adjustment. (Methods for making this determination of seasonal frequency are described in Chapter 18, Hydrology Handbook - for Watershed Planning).

Upon the determination of the seasonal distribution of flooding, a composite acre value for each stage is developed and the damage is calculated for each time period, usually by months of the growing season. The composite acre damage for each time period is then weighted by applying the percent likelihood that a damaging flood will occur. The weighted damage by time periods is then totaled to determine the annual composite monetary damage (See Table 3.2). This calculationn makes possible damage estimates by flood stages leading to the development of a stage-damage curve for the reach.

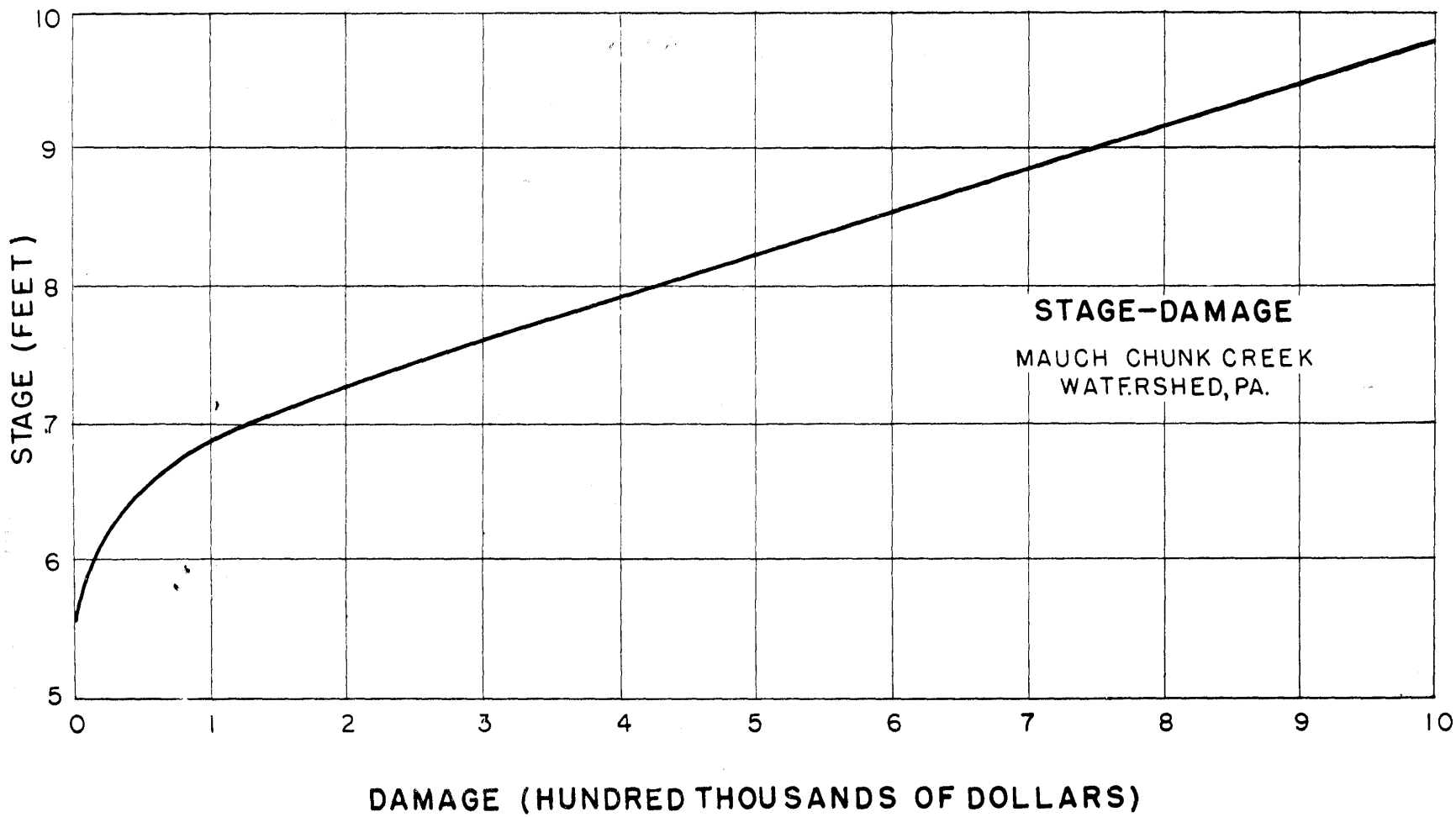

STAGE-DAMAGE
MAUCH CHUNK CREEK
WATERSHED, PA.
STAGE (FEET)
10
9
8
7
6
5
0
1
2
3
4
5
6
7
8
9
10
DAMAGE (HUNDRED THOUSANDS OF DOLLARS)

Figure 3.1

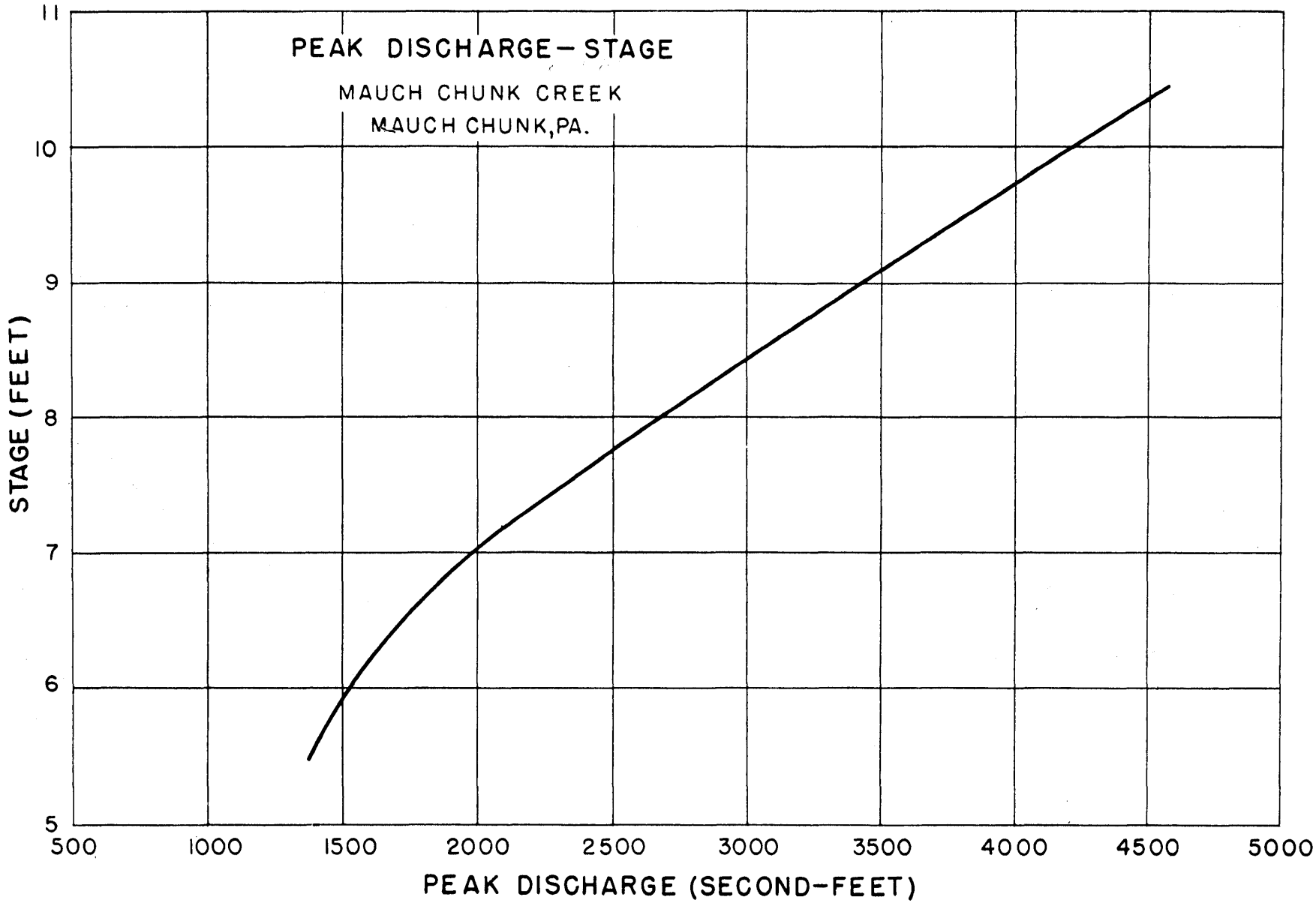

PEAK DISCHARGE-STAGE
MAUCH CHUNK CREEK
MAUCH CHUNK, PA.
STAGE (FEET)
11
10
9
8
7
6
5
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
PEAK DISCHARGE (SECOND-FEET)

Figure 3.2

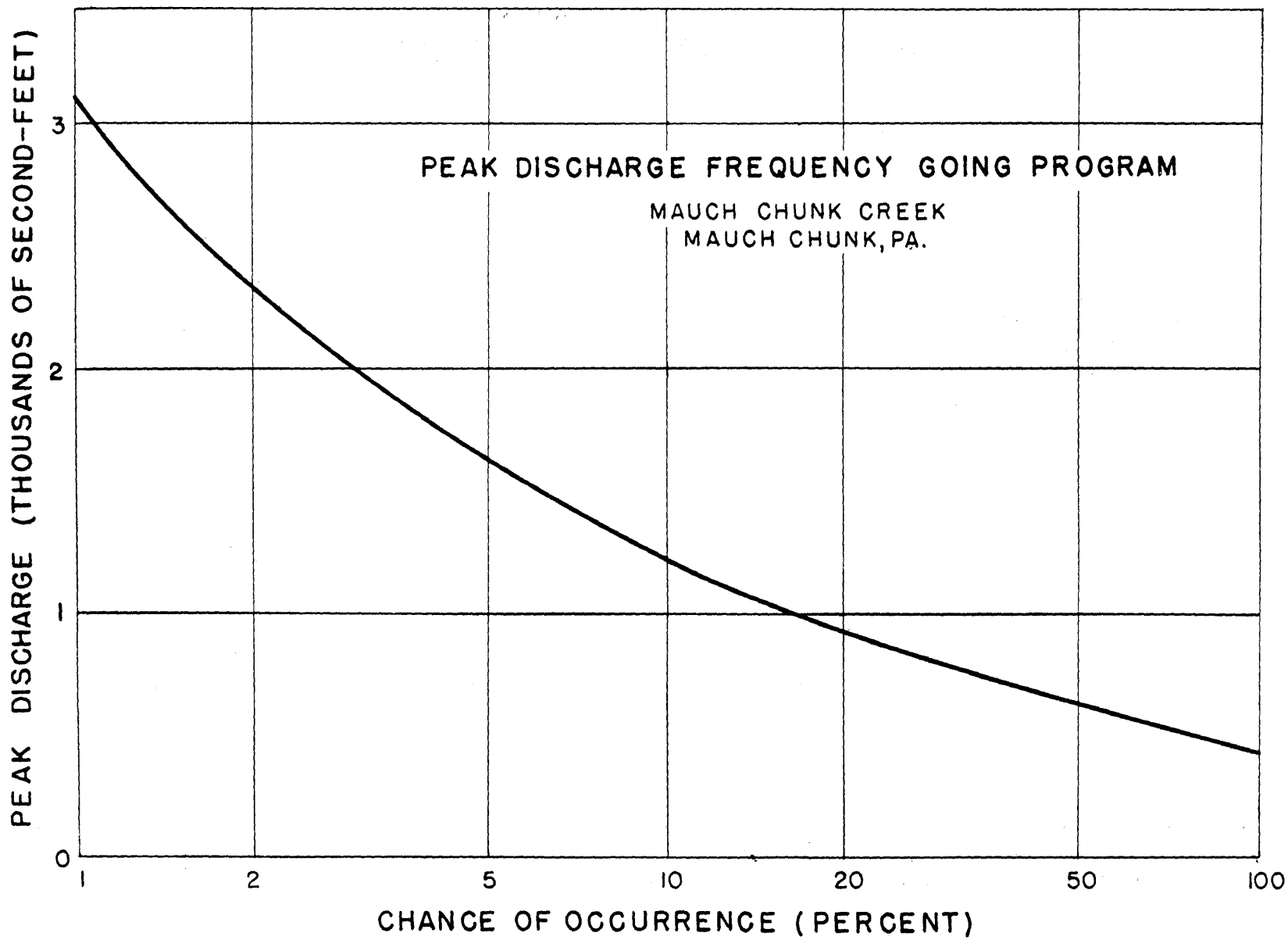

PEAK DISCHARGE FREQUENCY GOING PROGRAM
MAUCH CHUNK CREEK
MAUCH CHUNK, PA.
PEAK DISCHARGE (THOUSANDS OF SECOND-FEET)
0
1
2
3
1
2
5
10
20
50
100
CHANCE OF OCCURRENCE (PERCENT)

Figure 3.3

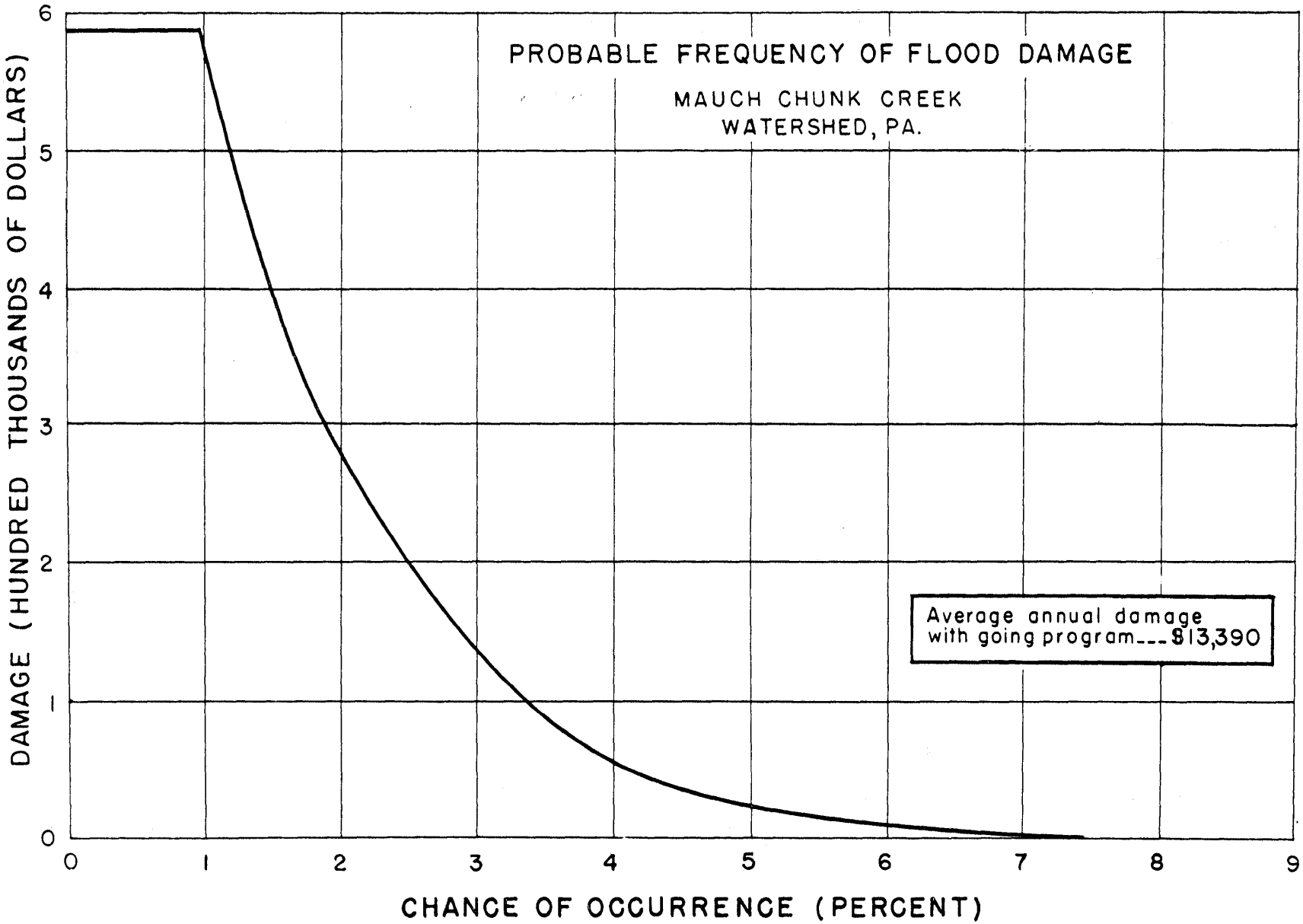

PROBABLE FREQUENCY OF FLOOD DAMAGE
MAUCH CHUNK CREEK
WATERSHED, PA.
Average annual damage
with going program---$13,390
DAMAGE (HUNDRED THOUSANDS OF DOLLARS)
0
1
2
3
4
5
6
CHANCE OF OCCURRENCE (PERCENT)
0
1
2
3
4
5
6
7
8
9

Figure 3.4

TABLE 3.2

Frequency Method

Sample Calculation of Cropland and Pasture Stage-Damage Relationship at 2' Stage for Reach I

Time Period	Damage at 2' Stage per Composite Acre ($)	Percent Chance of Flood Occurrence in any 1 Year	Weighted Per Acre Damages ($)
January	0	5	0
February	0	5	0
March	.48	15	.07
April	1.35	15	.20
May	6.85	5	.34
June	20.00	5	1.00
July	56.00	5	2.80
August	61.00	5	3.05
September	32.00	10	3.20
October	15.00	15	2.25
November	1.80	8	.14
December	0	7	0
TOTAL	xxx	100	13.05

Number of acres in reach at 2' stage = 85 acres.

85 acres x $13.05 damage per composite acre = $1,109.25 crop and pasture damage in Reach I at 2' stage. (Although the value calculates to $1,109.25, it is suggested that it be rounded. In this case for plotting purposes $1,100 probably would be the limit of accuracy.)

When crops are flooded more frequently than once a year, the damaging effect of the succeeding flood is altered by the effects of the previous flood. Two 100 percent chance events occurring during a given crop year will produce less total damage than if they were to occur in successive years, although the probability of either sequence is about the same. Therefore, it is necessary to adjust the crop damage estimates to account for recurrence of flooding. It is essential that the method of adjustment take into account the fact that if the project is effective a greater adjustment will be needed for non-project than for project conditions. The project can be expected to eliminate some recurrent flooding.

B. Historical Series Method

In using the historical series method, an evaluation period is selected where the cumulative annual departures from normal precipitation are minimized. Essentially this method rests upon the assumption that a sequence of events that has occurred in the past also may occur in the future. Floods of extreme magnitude (usually those with an expected recurrence interval of twice the evaluation period, or longer) should be excluded from the series unless appropriate adjustments are made.

After each of the various categories of damage have been appraised for each flood during the evaluation period under future conditions without the project, they should be summed and divided by the number of years in the period. The answer is the unadjusted average annual damage. The figure is then adjusted for recurrent flooding, or otherwise as needed, to obtain the average annual damage.

Caution should be observed with regard to the evaluation period. It often happens that the period of record of stream gages or rain gages involves fractional parts of a year. Evaluation periods should comprise complete years, dropping all fractional periods from consideration. Unless floods occur annually, an error may be introduced by starting and ending the evaluation period with floods. For example, flood damages may be estimated for a period of 20 years (1937 - 1956 inclusive) during which time 7 floods occurred. An examination of the record (or other reliable sources) shows that the last flood previous to 1937 occurred in 1934. Hence the flood period covers more than 20 years.

The flood series should be adjusted by dropping from consideration small floods that occur in such close proximity to larger ones that restoration of damageable values would not be possible.

Stage-damage curves are developed when the historical series method is used. As the dates and sequence of flooding are available, separate curves usually are developed by months or seasons. When depth of flooding is the chief determinant of the rate of crop damage from a given flood, the hydrologist may develop curves which relate the

acreages flooded within different depth zones to flood heights. A sample of a set of curves of this type is shown in figure 3.5. It is assumed for illustration that during the spring season, the crop damage along this reach for different depths of flooding are:

0 - 1 foot - $3.00

1.1 - 3 feet - 5.00

Over 3 feet - 7.00

The acres flooded at different depths by flood stage from figure 3.5 multiplied by these damage rates will provide the basis for development of figure 3.6.

Then figure 3.6 illustrates the appropriate stage-damage curve for crop damage in this reach from spring floods.

It is possible in the historical method to develop a single stage-damage curve for the entire year by weighting the damage factors by the seasonal occurrence of flooding. However, this procedure results in little, if any, saving in time.

When using the historical series it generally is found that several floods occur during a single year. In other years there may be no flooding. In such cases it is incorrect to add the unadjusted damage to crops and pasture for each flood in the evaluation series and use the sum as the total damage. The first flooding during the year will reduce the value of the crops somewhat so the second flood will find less value to damage. Some portion of the value sometimes may be restored between floods through replanting or otherwise but the yield of the late crop usually will be reduced. One method of calculating these changes in value, and in resulting damage, is by making a flood-by-flood analysis. These calculations are laborious when an evaluation series includes a considerable list of floods.

Calculations of this type have been used to develop empirical short-cut formulas to adjust damages for recurrent flooding. One such formula used in several states is represented by the equation $1/Y = 0.7706 + 0.2387X$. Here X is the sum of the areas flooded by all floods in the series divided by the sum of the areas flooded by the largest flood each year. Y is the percentage of the damage, as calculated from the individual flood events, to be used in correcting for recurring floods. This equation does not provide for restoration of value between floods.

An example of the correction under this equation follows: The total acreage flooded by all floods in a 20-year period was 200,000 acres. There was no flood one year and the sum of the acreages flooded by the largest flood each year was 80,000 acres. X therefore equals 200,000/80,000 or 2.5. The average annual damage found by considering

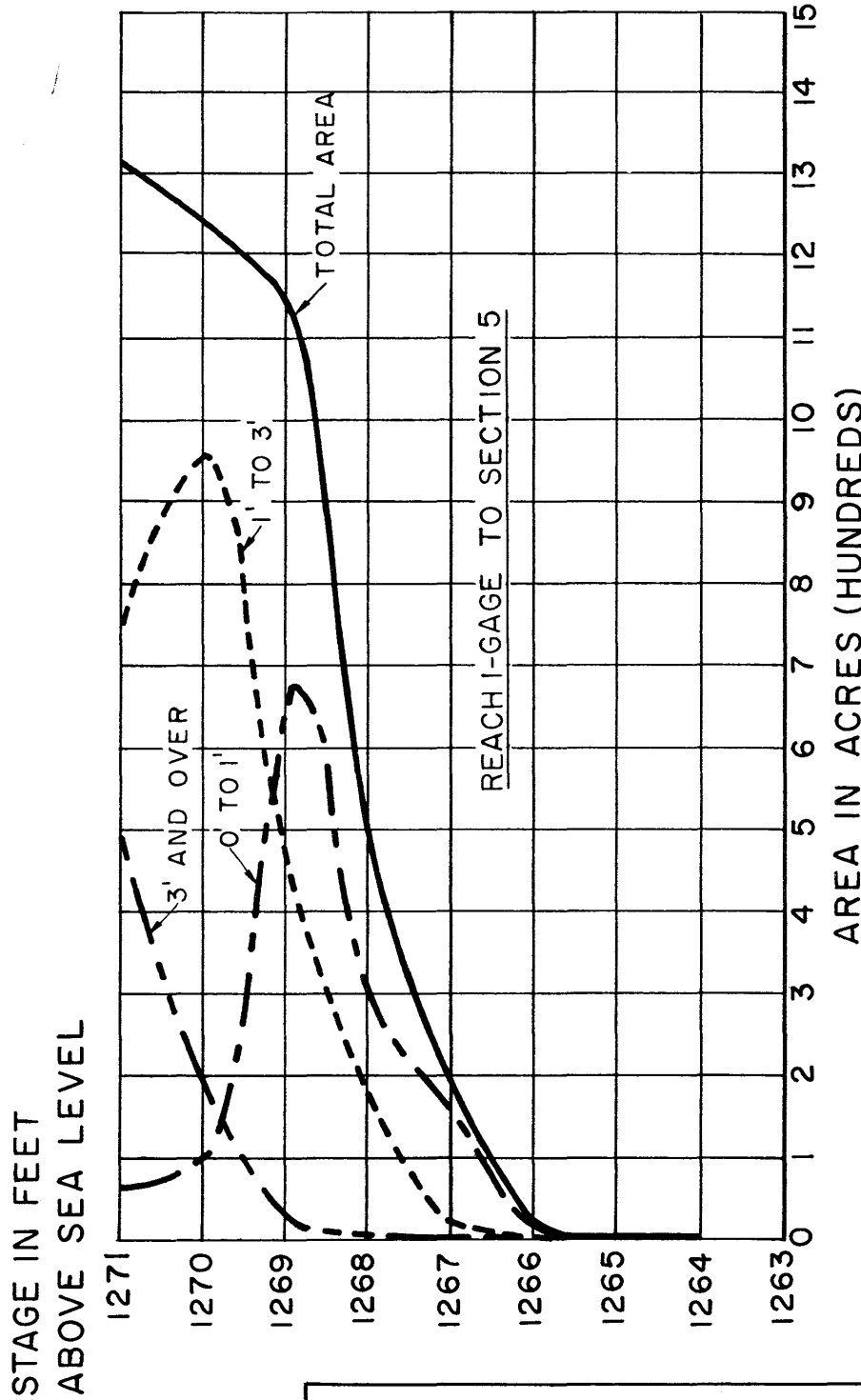


Figure 3.5
INUNDATED AREA CURVES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

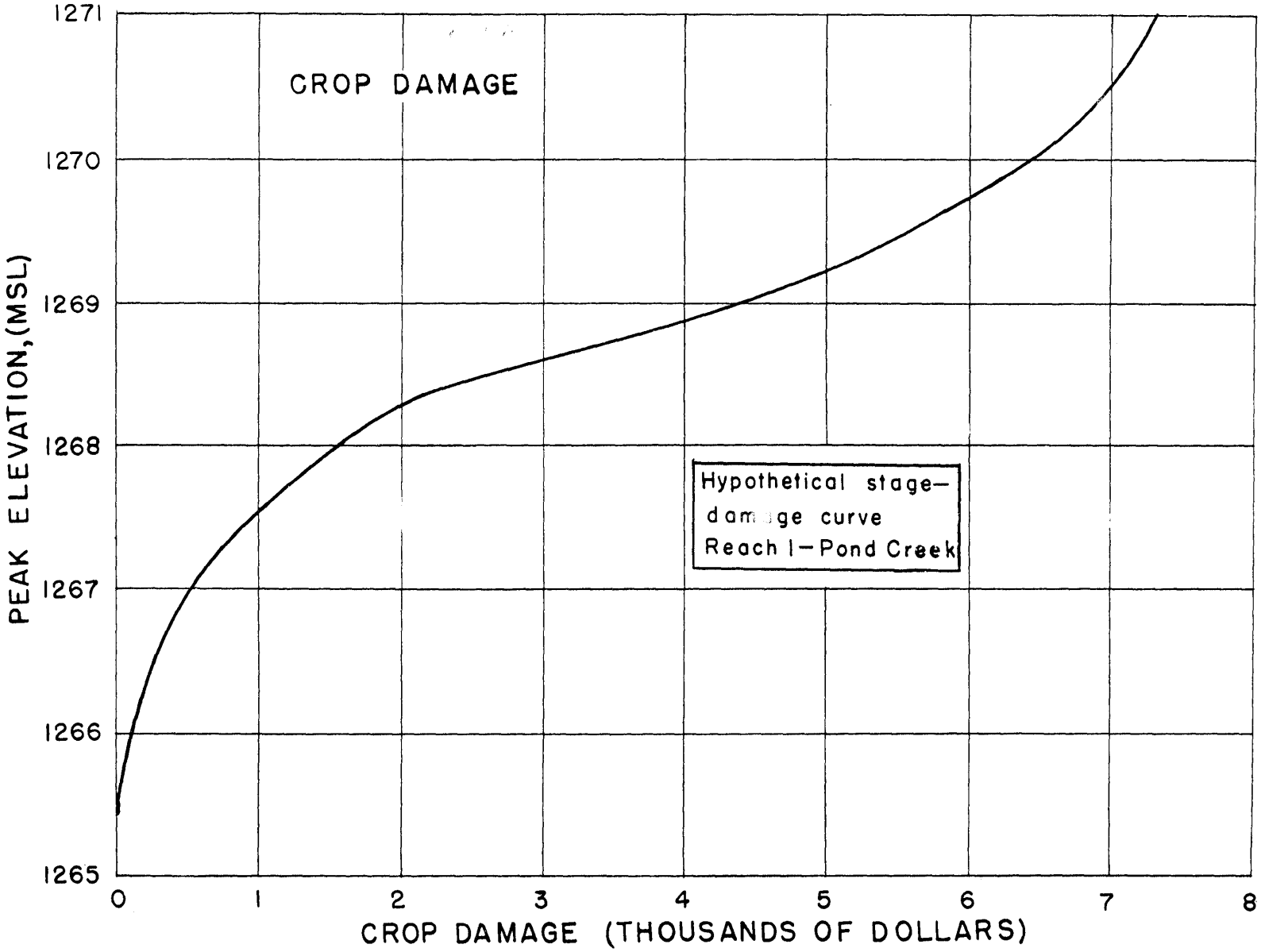

CROP DAMAGE
Hypothetical stage–
damage curve
Reach I–Pond Creek
PEAK ELEVATION, (MSL)
1271
1270
1269
1268
1267
1266
1265
0
1
2
3
4
5
6
7
8
CROP DAMAGE (THOUSANDS OF DOLLARS)

Figure 3.6

each flood separately was $50,000. Substituting in the formula, $1/Y = 0.7706 + 0.2387\ (2.5) = 0.7706 + 0.5968 = 1.3674$. Then $Y = 0.7313$ and the adjusted average annual damage would be $50,000 x 0.7313 or $36,565.

The approach gives less correction for recurrence under project conditions than for conditions without project. Such a result is in accord with experience. The project is likely to eliminate a number of small floods but it probably will have less effect on the large ones. Hence there is less recurrent flooding.

In the states where it is used, the equation has been tested repeatedly and found to give results which seldom differ by more than two percent from those obtained through a flood-by-flood approach. Presumably in other areas of the country where growing seasons and crops are different, a somewhat different equation should be derived.

The historical series method requires somewhat more work for the hydrologist and economist than does the frequency method. However, when flooding is frequent and the major damage is to crops and pasture it allows a positive approach to the adjustment of damages from recurrent flooding.

C. Overland Flow

In some watersheds tributary ephemeral streams may discharge their floodwater onto alluvial areas with no defined channel to the main watercourse. Usually these alluvial areas are flat or only gently sloping in both directions and the floodwater spreads out until the flow eventually is dissipated. This situation wherein there is virtually no channel or where the possibility of lateral spreading is great is called overland flooding.

Under natural conditions, these alluvial areas were natural spreading areas for runoff. Because of favorable topographic and soil characteristics many have been developed into highly productive farming areas and in some cases into urban and suburban areas. The increased value of property and its greater susceptibility to damage, together with the inability of individuals to protect their property because of the unpredictable path of the flood flows, has created serious local flood problems.

Peak discharge and flood stage have little meaning in overland floods. When the floodwater emerges from the confined section onto the alluvial fan or plain the flood peak quickly flattens. As a result, the area flooded is not a direct function of the peak discharge except as it may overtop diversion dikes built to direct its course away from a portion of the flood plain. More often, the area flooded is directly related to the flood volume. The greater the volume, the greater is the area flooded.

The relationship is illustrated in the White Tanks Watershed in Arizona. Floodwater from this watershed debouches from the White Tanks Mountains onto a highly productive gently sloping flood plain. Once the floodwater breaks through the highline irrigation canal, it spreads out over the farm land in relatively shallow sheet flows except where it is concentrated or obstructed by railroad and road fills, ditches or other man-made obstacles. It seldom reaches the Agua Fria or Gila Rivers. The relationship between flood volume and acreage flooded is shown in the following tabulation:

Flood Date	Volume Acre-Feet	Acres Crop Land Flooded	Acres Flooded Per Acre-Foot
August 1939	3,500	4,600	1.3
September 1956	7,000	7,500	1.1
September 1949	2,500	3,000	1.2
January 1951	5,500	7,000	1.3
July-August 1951	11,500	14,100	1.2
Total	30,000	36,200	1.2

A large area of cropland in this watershed lies in the flood plain. Not all would be subject to flooding by a single flood, but most is subject to the flood hazard by slight changes in the paths of flood flows. Even the 100-year flood would inundate only about 25 percent of the flood damage area.

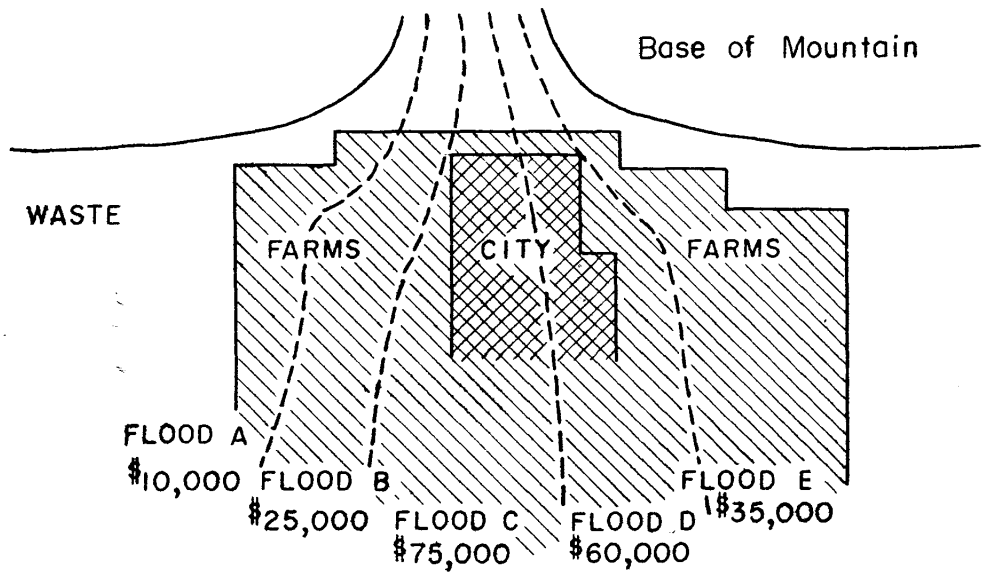
In overland flow situations with relatively little ponding, farm damage per acre flooded appears to be relatively constant irrespective of the size of the flood. This is illustrated again in the following tabulation for the White Tanks Watershed for two floods, both of which occurred in August.

Type of Damage	1939 Flood	1951 Flood
Crop	$28.75	$28.60
Land	8.89	10.14
Farm ditches	3.91	3.60
Miscellaneous farm damage	1.69	3.11
Total farm damage/acre flooded	$43.24	$45.45

Since the 1951 flood was over three times as large as the 1939 flood, it was concluded that flood damage was proportional to the acreage flooded, which in turn was proportional to the flood volume. Hence, it was necessary only for the hydrologist to determine a flood volume-frequency series to provide a basis for determining average annual flood damages over a normal hydrologic period.

Overland floods seldom follow the same path. During the interval between floods, even minor changes in the flood plain such as small dikes, road and railroad fills, irrigation ditches or even land leveling have been known to alter the course of flood flows. Sediment deposition where there is an abrupt change of grade is also an important factor in altering their course. This unpredictability is not particularly important where there is homogeneity in the flood plain. However, many alluvial fans or other alluvial areas exhibit a wide variety of damage potential due to differences in kind and extent of development. If a flood strikes the developed area of the flood plain serious damage may result, whereas if it followed a path through the undeveloped area little or no damage would occur. Hence, it is necessary in such situations to determine the mean damage resulting from a flood of certain size, taking into consideration the probability of the flood following any one of several possible paths.

This problem is illustrated in the following sketch:



Through the use of topographic surveys, aerial photographs, and maps of historical flood flows, flood paths A, B, C, D and E are traced through the flood plain. Flood damages are determined from known relationships between damages, flood depths, and velocity. If a flood of the magnitude being studied has an equal chance of following each of the flood paths then the probable damage from such a flood is equal to the mean value of the five alternatives which in this example is $41,000. Similar studies made for floods of different magnitudes would furnish the basis for damage-discharge curves.

In the arid regions where the overland flow technique has been used most frequently, there are only a few floods in a 20-year period. The few gage records that exist indicate that even when floods are so infrequent, there are generally two or three years during which more than one flood occurred. However, recurrent flooding during a single year over the same area is unlikely because of the alternative paths the flow can take.

Either the historical series or the frequency method may be used in the overland flow analysis. The distinction between overland flow and the usual methods of analysis is that here the hydrologist determines the total flood volume instead of flood routing to establish peak flows.

D. Net Income

A method which theoretically is sound, but which is likely to have practical difficultues, is the evaluation of flood damage and the benefit from its reduction through the change in net income after project installation. This procedure is applicable where nearly all damage is to crops and pasture and the control of flooding after project installation will be almost complete. It also is used in most cases where inseparable flood prevention and agricultural water management benefits are being evaluated.

The procedure consists of determining the land use, average crop yields and net return without project and comparing these with flood-free yields, the degree of restoration to former land use, and the net return under project conditions. The difference in the net return constitutes the flood damage. The increase in the net return over non-project conditions as a result of project installation constitutes the project benefit through reduction of damage. Additional benefits may accrue through increasing the intensity of land use beyond that which has been attained in the past. In most cases, as in combined flood prevention and drainage, there is no need to separate the benefits from restoration from those resulting from land use change or intensification.

A major difficulty is to determine how closely the average crop yield after project approaches the flood-free yield when protection is incomplete. Another problem is the determination of additional production costs under these circumstances.

Nevertheless, this procedure can shorten greatly the work required for damage appraisal. The effect of recurrent flooding is considered automatically in determining the yields and land use under non-project conditions.

III. STEPS IN DAMAGE APPRAISAL

The following outline of steps necessary to appraise floodwater damages adequately is applicable to many varied situations. Unusual conditions may require some adaptations. Understanding of the principles involved will provide a basis for making the adaptations necessary to cope with unusual problems.

A. Selection of Areas for Study

To obtain statistically reliable data in watersheds covering only a few square miles, it may be necessary to obtain information on the entire flood plain. However, a sampling procedure should be employed where practical. On larger watersheds a sampling procedure usually should be employed in all cases.

The first step in selection of a sample for detailed investigation is a careful reconnaissance of the whole area to be studied so that all major problems or conditions will be sampled. Stereoscopic analysis of flood plain photographs will be useful.

The selection and use of appropriate stream and flood plain reaches provide a means for (1) identifying the location of damages and benefits; (2) bringing the evaluation of hydrologic and economic data together for determination of stage-area-damage relationships; and, (3) relating damage reductions or other benefits to works of improvement.

In setting up the sample of areas for detailed investigation, attention to these points is important:

1. Important variations in flood plain characteristics and in land use should be considered. (An example of this would be where a flood plain crosses two or more problem areas or if an urban area is involved.)

2. Both sides of the stream should be represented.

3. Differences in channel size and valley width from the headwaters to the bottom reaches should not be overlooked.

4. Portions of the flood plain should not be excluded from the possibility of being drawn in the sample for any reason.

5. The selection should facilitate separate evaluation of individual structures or groups of structures.

B. Collection of Basic Data

1. Maps

Major land use in the flood plain may be mapped on aerial photos, overlays, or sketches, depending upon the need. The map should show improvements such as roads, buildings and bridges subject to damage. Where urban and residential areas are subject to flooding it is desirable to use a detailed map. Many towns and cities have maps that will help fill this need. Land use capability classes and soil delineations also may be shown on the flood plain map. It usually is not necessary to show crop distribution throughout the flood plain, however, it will be desirable to show crop distribution in a few representative sample valley sections. Locations of areas significantly affected by flood plain scour, deposition and streambank erosion may be delineated on the map to complement the investigations of the geologist.

2. Cost and Price Data

Production cost data usually are available from State Colleges of Agriculture. Local agricultural workers can assist in providing information on the farming operations common to the area. Most of the Engineering and Watershed Planning Units have developed costs of producing various crops applicable to fairly wide areas such as a Land Resource Area. If a given operation, such as combining, usually is done on a custom basis in a community, the custom price may be considered as a cost of operation.

When using cost data from the various sources, care should be taken to check its applicability to watershed planning. The following are among the points to consider. The price base should be known so that prices can be converted to projected levels. The economist should find out exactly what items of cost his data include. Among these are interest and depreciation of equipment, labor whether hired or unpaid family, and cost of obtaining and applying fertilizer and insecticides.

3. Collection of Field Information

Information regarding damages experienced may be obtained from the operators of flood plain land. It is recommended that this information be recorded on a flood damage schedule rather than loose notes to make sure that comparable information is obtained from all respondents. Figure 3.7 is a sample schedule illustrating the general type of data needed.

This information will furnish basic data for estimating damageable values and rates of damage for all classes of agricultural property or will provide the basis for making adjustments to standard damage data already developed.

Flood Damage Schedule Work Sheet
(Sample)

Name _____ Years on Farm _____ Subwatershed _____

Flood of _____ Acres Flooded _____ How frequently do floods of this size occur _____

Acres Flooded by Largest Flood _____

NOTES

Damage to Crops and Pasture From Flood of Above Date

Crop	Depth	Acres Flooded	Present Acres This Crop	Expected Yield If No Flood	Yield After Flood	Extra Cost Kind	Extra Cost Amount	Expenses Saved Kind	Expenses Saved Amount
Cotton	0'-2'	10	5	200 lb.	150	Replant Extra	10	Picking	50 lbs/ac
Corn	0'-2'	10	5	30 bu.	15	Cultivation	10	Harvest	15 bu/ac
Wheat	2.1'-4'	10	10	15 bu.	10	Combines	10% longer to harvest	None	
Johnsongrass Meadow	2.1'-4'	5	15	1 ton	1	None	-	None	
Pasture	4.1'-6'	10	10		No damage				

Other Damage From this Flood

Type	Quantity	Value
Fence	4 rods	
Poultry	12 hens	
Livestock	1 heifer	

Damage	
Equipment	None
Levees	None
*Scour	5A/20%
*Bank Cutting	
*Sediment	5A/25%

Value of Cropland: $100 acre

Value of Pasture: $30 acre

Q. What changes in land use have been made due to floods? A. 10 acres of row crops to Johnsongrass meadow.

Q. What changes would be made if the frequency of flooding were reduced by half? A. All of meadow to crops and 5 acres of pasture to crops.

Q. How often do large floods occur? (If the flood described above is a large flood, change this question to small floods.) A. Once in 8 years.

Q. During what seasons are floods most common? A. Large floods: Spring - 1/2; Fall - 1/2. Small floods: Spring - 3/4; Fall - 1/4;

Q. In addition to the loss in yield described above, was there any damage to quality of crops? A. Wheat-weeds because wheat down. (Estimated percent. Docked price of wheat 25%.

Q. What damage did this flood do to roads and bridges nearby? A. Washed out approaches, about 10 loads needed.

*These items may be total damage since he has been on the farm.

Figure 3.7

Many farmers can give information about only one flood. This may be the most recent, the largest, or the most damaging he has experienced. However, information should be obtained on as many floods as possible. The enumerator should obtain as accurately as possible the proportion of cropland in the various crops. Although normal crop rotations will cause different crops to occupy a given field from year to year, the over-all distribution should reflect the situation in the flood plain. It can be expected that some cropland will be idle. The division of the flood plain among cropland, pasture, woodland and other uses in some cases can be determined by planimetering recent aerial photos of the flood plain.

The data thus obtained usually represents present land use and cropping patterns. Adjustments should be made where these data do not represent the expected future land use and cropping pattern without project. Evaluation of conditions as they may be affected by the project is described in Chapter 4.

Most of the information collected through farmer interviews should be in terms of physical quantities rather than values. Their monetary evaluation should be made in the office. Otherwise, much time will be used in trying to determine what items the farmer has included in his value estimate and the price base he has used.

Information on damages to non-agricultural property also may be obtained and recorded on appropriate flood damage schedules. Special schedules may be needed to record damages to residential, commercial, and industrial property as well as to highways, bridges, railroads and utilities. Figure 3.8 shows a sample schedule for residential flooding. If there are numerous residences subject to damage, a sampling procedure may be used. When there are considerable differences in the types or values of the affected residences, the sample should be stratified to reflect these differences. Commercial and industrial establishments are so varied in their equipment, inventory, and susceptibility to damage that a complete inventory is advisable in most small watersheds. Except for residential damage, most non-agricultural damage data will require less editing in the office than is needed for agricultural damage. Reasonably accurate records generally are used in industrial or commercial enterprises.

C. Analysis of Damage

Damage estimates are based upon information obtained in the field. This information constitutes the raw data which must be analyzed and processed before it can be correlated with data worked out by other specialists to obtain an accurate appraisal of the effects of the project.

The planning party is faced at all times with the problem of balancing scanty data with the cost and the time required to obtain and

FLOOD DAMAGE - RESIDENTIAL
(Sample)

Watershed _____ Reach _____

Location of property: Stream mile _____ No. _____

Occupant _____ Years Occupancy _____

Damaging floods: No. _____ Dates _____

APPRAISAL OF DAMAGE

Property damaged	Experienced or Potential Floods 1/		
	Extent of damage		
Residence and contents			
(Depth of water in basement)			
(Depth of water on first floor)			
Foundation			
Basement and contents			
Floors and walls			
Furniture			
Personal belongings			
Lawn			
Garage (depth of water)			
Other buildings (depth of water)			
Automobiles (depth of water)			
Other losses			
Clean-up			

Relevant Data:
Type of residence: Frame _____ Masonry _____. Size of residence _____ square feet. Market value of residence $_____. Replacement value of furniture $_____. For experienced flood describe any emergency activity for prevention of losses or evacuation _____

1/ Indicate the date of experienced floods. Show height of other flood stages in terms of plus or minus depth increments referenced to the experienced flood.

Figure 3.8

analyze more complete information. It may be necessary to adopt certain assumptions and to develop short-cut procedures in order to obtain reasonably accurate answers with minimum planning costs. In so doing, it is important to remember that assumptions are not necessarily facts.

1. Crop and Pasture Damage

The floodwater damage that will be sustained by crops and pasture depends upon the damageable value of the crop, the seasonal occurrence and frequency of flooding, and the characteristics of the flooding such as depth, velocity of flow, sediment load and duration. The damage schedules can form the basis for estimating many of these factors.

The yield which would have been obtained in a watershed had there been no flooding is a hypothetical figure. Flood plains of creek watersheds are so small that accurate yield data from secondary sources seldom are available. Basic data on the yields to be expected in the flood plain can be obtained from the schedules, but these should be scrutinized rather carefully.

The data obtained from the schedules may be biased as many other things might have happened to reduce the yield had a flood not damaged or destroyed the crop. The reported yields should be adjusted in the light of knowledge of fertility, farming methods, etc., in the area. Excellent data on crop distribution and yields often may be obtained from ASCS offices. The degree of damage from scour and overbank deposition of sediment reported by the sedimentation party also should be considered.

The flood-free yield so determined may be adjusted further by consideration of the effect that improved technologies may have during the project life. Some agricultural colleges and experiment stations have developed estimates of the yield increases that can be expected from this source at various benchmark dates. Other estimates have been made as a part of river basin studies. An assumption often used is that the best practices now in use will be common within 15 or 20 years. Benchmark yield data from Work Unit Technical Guides may be useful. In estimating future flood-free yields without the project, consideration should be given to the degree to which the risk of flooding will inhibit the full use of improved techniques.

Percent damage factors are derived for each crop to relate the damage to the month or season and the depth or duration of flooding. An example of steps required in the estimation of the percent damage to a given crop at each depth increment of flooding during a given month or season is shown in table 3.3. Similar procedures can be used for other depths or duration of flooding and for other seasons or months. This procedure should be repeated for each of the crops in the flood plain.

The schedules that can be obtained in most watersheds will not furnish adequate information for determination of the percent damage factors for all months or seasons and perhaps for all depths or durations, because information usually can be obtained in a creek watershed on only a few floods. Damage information that previously has been obtained in similar areas may be used to supplement field data on a given watershed to indicate general relationships and to fill in gaps where the field data are inadequate. It is desirable, however, to calculate some basic percent damage factors for each watershed because of differences among watersheds in velocity of flow, soil detachability, topography or sediment load.

The major land use may be determined from the flood plain map. The present crop distribution in the flood plain can be obtained by adding the figures shown in the present acreage column from the schedules. Usually it is desirable to adopt the land use acreage at the year planning is begun to represent present conditions. If there are obvious reasons for making adjustments to reflect normal conditions more nearly, the acreages should be adjusted. A final adjustment will be the conversion of the existing use to that which can be expected in the future without project.

In some cases a uniform land use can be assumed in the flood plain. On other watersheds inspection of the flood plain may show a considerable difference in land use between upper and lower reaches of the stream. If this is the case, different land uses and damageable values should be used for the two (or more) reaches. Sometimes there may be significant variations in a given cross section in land use with elevation above the bankfull stage. The acreage inundated first may be woods or idle land in which there is little or no damage. If this is the case, it should be separated from the acreage damaged by flooding.

Table 3.4 shows a method of calculating the composite damageable value per acre of flood plain, when uniform land use is assumed.

The damageable value of each crop, determined as shown in table 3.4 can be multiplied by its percent damage factor and the products added to give the damage from flooding an average acre of flood plain to a given depth during each season. Table 3.4 illustrates a procedure.

The damage rates are multiplied by the acreages inundated for representative stages to develop crop damage curves, similar to that shown in figure 3.6. Development of damage curves for seasons rather than one for each month is adequate in most cases. This will substitute the development and reading of three or four curves for the twelve otherwise required.

Table 3.3 Flood Damage to Cotton, 3' and Over, Spring Flood, Village Creek.
(Sample)

Schedule No.	Acres Flooded	If No Flood: Estimated Yield	If No Flood: Total Production	If No Flood: Price Per Unit	If No Flood: Total Value	After Flooding: Actual Yield	After Flooding: Total Production	After Flooding: Price Per Unit	After Flooding: Total Value	Gross Damage	Expenses Saved	Net Value Alternate Crop	Added Expenses	Net Damage
	(1)	(2) (lbs)	(3) (lbs)	(4) $	(5) $	(6) (lbs)	(7) (lbs)	(8) $	(9) $	(10) $	(11) $	(12) $	(13) $	(14) $
72	40	300	12,000	0.386	4,632	0	0	0	0	4,632	1,782	916	0	1,934
121	10	135	1,350	0.386	521	0	0	0	0	521	162	0	0	359
114	8	250	2,000	0.386	772	133	1,064	0.386	411	361	112	0	10	259
Total	58	228(av)	15,350		5,925		1,064		411	5,514	2,056	916	10	2,552

Damage Per Acre Flooded $44.00

Percent damage 43

Procedure: Column (1) x Column (2) = Column (3). Column (3) x Column (4) = Column (5).
Column (1) x Column (6) = Column (7). Column (7) x Column (8) = Column (9).
Column (10) = Column (5) minus Column (9).
Column (14) = Column (10) plus Column (13) minus the sum of Columns (11) and (12).

Table 3.4- Composite Damageable Value Per Acre of Flood Plain
(Sample)

Crop Use	Percent in This Use	Unit	Yield Per Acre of Crop	Production Per Flood Plain Acre	Value Per Unit (Dollars)	Damageable Value (Dollars)
Corn	6.3	bu.	30	1.89	1.24	2.34
Cotton	6.3	lb.	183	11.5	0.386	4.44
Oats	10.5	bu.	33	3.46	0.81	2.80
Wheat	6.6	bu.	18	1.19	2.00	2.38
Hay, (J.G.)	0.3	tons	2.0	0.006	16.22	0.10
Pasture	67.0	A.U.M.	2.50	1.68	2.61	4.38
Misc.	3.0					

Table 3.5- Composite Crop and Pasture Damage Rate, per Acre Flooded, by Depth of Flooding, Spring Season (April, May and June)
(Sample)

Crop	Damageable Value Per Acre (Dollars)	Net Damage: Depth 0 - 1.0' (Percent)	Depth 0 - 1.0' (Dollars)	Depth 1.1' - 3.0' (Percent)	Depth 1.1' - 3.0' (Dollars)	Depth 3.1' and Over (Percent)	Depth 3.1' and Over (Dollars)
Corn	2.34	26	0.61	35	0.82	47	1.10
Cotton	4.44	17	0.75	41	1.82	52	2.31
Oats	2.80	32	0.90	50	1.40	63	1.74
Wheat	2.38	33	0.76	50	1.19	63	1.48
Hay, (P.G.)	0.10	20	0.02	23	0.02	36	0.04
Pasture	4.38	10	0.44	18	0.79	20	0.88
Total			3.48		6.04		7.55

The above illustrates a procedure for watersheds where depth of inundation is more meaningful than duration of flooding. This is the situation on most watersheds. However, when water gathers on a wide, relatively flat flood plain it may remain for a considerable time. If this occurs duration may be the most important factor. Increments of duration may be handled in a manner similar to that illustrated for depth increments.

2. Other Agricultural Damage

The damage schedule should contain spaces for recording such other agricultural damage as livestock losses, damages to fences, farm equipment, farm levees, etc. It is suggested that the physical amount of such damage be recorded and monetary values be determined in the office. One reason is that if a farmer reports $100 damage to his fences from a flood in 1958, he may be thinking of what it cost him then, or he may have in mind what it would cost at today's prices. A second reason is that when a farmer gives damage in monetary terms, one needs to have a definite understanding of whether he means only out-of-pocket cash costs or such costs plus the value of unpaid family labor or a complete cost including interest and depreciation on farm equipment. Such monetary values are more difficult to pin down where fences, livestock, etc. are involved than if only crop values are concerned.

Seasonal curves for these other agricultural damages ordinarily will not be needed. Damages of this type may not start until a fair stage overbank is reached. As an example, floodwater probably will need to be at least two feet deep before there is much damage to fences. On the other hand, damage from infestation by noxious weeds may begin at a low flood stage. The sampling procedure used for estimation of crop and pasture damage will be applicable to estimates of damage of this type. Expansion of data from the sampled areas to the entire flood plain can be made safely if the sampling has been done correctly.

When irrigation, drainage, or farm levee systems exist in a watershed and are subject to flood damage, they should be given special consideration and evaluated separately. For example, the damage to an irrigation system might consist only of silting up the ditch or washing out a siphon but before repair of such damage could be made the inability to use the system might cause loss of a crop because of lack of water.

3. Nonagricultural Damage

Most of the damage in small watersheds may be to agricultural property, with a certain amount of damage to such transportation facilities as roads, bridges and railroads. In some areas, however, there will be damage to residential, commercial, and industrial property and to parks, schools and the like. Appraisal of these damages often will require special treatment. A random sample of the flood

plain cannot be drawn for this purpose, because the areas subject to damage are localized and the concentration of damage per unit of area is high. Appraisal will require specific consideration of each damage area in order that damages may be related to flood stages.

Complete enumeration of damages may be impractical in case a large urban area is flooded. In such an event, an adequate sample should be drawn from the flooded urban areas. Care should be taken that residential sampling represents important value groups of housing. Commercial establishments of the same type may be sufficiently similar in values and susceptibility to damage that samples of each type of establishment may be drawn. But, for example, furniture store damage should not be used to represent supermarket damage. The diversity in industrial plants is such that each usually must be evaluated separately.

When protection of an urban area is a principal project objective, a detailed map of the area subject to flooding should be prepared. Enough valley sections should be surveyed to enable the hydrologist to prepare flood flow lines that will show area flooded by the largest flood of record or the design flood both without and with the project. Such a map will be of use to the economist in evaluating flood damages and benefits from flood reduction.

The map will enable the economist to inventory the damageable value of the property in the flood plain. Upon receipt of information on the area and depth of flooding by floods of various sizes, the economist can coordinate his information into a depth-damage curve for the area.

Although duration of flooding may be a factor in the amount of crop damage sustained, it may have limited effect on many types of nonagricultural damage.

Consideration should be given to the probable future development of the flood plain in urban areas. The tax rolls showing trends in assessed valuation in flood plain may provide useful information. Real estate men usually are in a position to appraise past development and provide some information on existing trends. City officials, such as planning boards, city engineers, city councils, mayors, and city managers, may be excellent sources of information. Organizations, such as chambers of commerce, can be helpful. Some general guidelines for evaluation of future development are given in section IV, A, 2 of this chapter.

Other secondary sources of information such as files of local newspapers will be of value in fixing the limits of floods experienced in the past. They also may contain pictures of the flood

and property damaged. Their appraisals of damage will be useful if the flood is of fairly recent date. If the value of property has changed significantly since the date of occurrence of the flood, the estimate of experienced damage should be adjusted to reflect the new values. Effects of protective measures that have been installed since previous flooding should be examined. Further adjustments for future development and projected price levels will be needed.

a. Roads and Bridges

Estimates of road and bridge damage may be obtained from State highway engineers, boards of county commissioners, county engineers, or township trustees. These data should be related to specific events and depths of flooding. Many times, however, such information is incomplete. A county commissioner may be newly elected and unable to report on the expenditures of his predecessors. Or he may have a certain sum to spend and keep no particular records regarding the proportion spent for ordinary maintenance and that for repair of damage. Recorded damages to roads and bridges may be inaccurate because of delayed maintenance or repair. A road or highway district may have only a budgeted sum for repair or maintenance which may cause total costs to be spread over several years. For these reasons, the sample flood damage schedule carries the question "What damage did this flood do to roads and bridges nearby?" It is believed that this information obtained from farmers and others will provide a check on the data from other sources. Probably they will have little information on costs, but they can pinpoint the location of major bridge and road damage. Furthermore, in some areas, farmers cooperatively repair some of the roads and bridges. When this is the case, the full cost of repairs may not be found in the books of public officials.

When obtaining information on historical damage to roads and bridges, it is necessary to find out the condition of the facility at the time it was damaged. Increased modern traffic and flood hazards often cause replacements to be better and less subject to flood damage than the original facility. When this has occurred or if it seems likely to occur in the future, damage estimates should be based on the new facility.

b. Railroads

Information on damage from severe floods to railroad property usually can be obtained from railroad officials. Caution should be observed in obtaining this information to make sure that it is complete, particularly if only partial repair is made immediately after the flood and complete restoration is deferred. The question also arises, with railroad damage, as to whether or not there is segregation of normal maintenance and flood repair expenditures when less than major floods are concerned.

Ordinarily, it is desirable to obtain as much information as possible from local railroad officials to supplement that obtained from company headquarters. Local people usually can give information on the location of track and bridges damaged and an indication of physical damage. Such information can be correlated with published data and information previously gathered elsewhere.

c. Residential

Flood damages to residences and appurtenances may constitute a large portion of the total flood damage in some watersheds even though no major concentration of population exists and only a few scattered houses in the flood plain are affected. Where this is the situation, damages to residences should be appraised separately in each case by making inquiry of informed residents.

Flood damages to such properties usually include some or all of items as: house, garage, septic tank, lawn, shrubbery, vegetable garden, orchards, sidewalks, fences, and small animal shelters. Mobile equipment on the premises at the time of floods may also be damaged.

Some district offices of the U. S. Corps of Engineers have compiled schedules of average damages to dwellings and contents when flooded to different depths. A study by the Stanford Research Institute contains much useful information. These and similar compilations may be helpful in supplementing data from the field but they should never be relied upon without field investigation to determine if they are applicable.

A damage form or schedule may be prepared to serve as a guide and a check list in estimating losses. When appraising and recording damages it is important to associate the damage with depth of inundation in order that stage-damage relationships may be established. The schedule sample included herein (figure 3.8) indicates the kinds of information required. With some modification it may fit the needs of most watersheds where residential damages occur.

To comply with the need for development of a stage-damage relationship, damage appraisal for several different flood stages is required. The range in flood stage for damage appraisal should extend from the point where damage commences to a stage possibly one or two feet higher than the maximum flood on record. Usually the highest stage for which damages are estimated is that of the 100-year flood.

On streams where flooding of houses is quite frequent, precautions should be taken to determine, (1) if repairs are made following floods and before succeeding floods occur, and (2) if flooded parts of the house or appurtenances are utilized in the normal or

"flood-free" manner. When building values are not maintained and when basements, for example, are not utilized for normal purposes because of frequent flooding, account of these conditions should be taken in adjusting damage appraisals downward from the losses which would occur under normal conditions. As an offset, however, it may be possible that upon protection full use will be made of the property and the value enhanced.

4. Other Floodwater Damage

There may be flood damage of types other than those described here in an occasional watershed. If so, the damage should not be neglected, although special procedures for its evaluation may need to be devised. As an example, flooding may leave stagnant pools in depressions which become breeding places for mosquitoes. The cost of mosquito control, insofar as it stems from this source is a flood damage. Loss of life in the watershed during floods, although not evaluated in monetary terms, should be reported as an intangible damage.

5. Indirect Damage

Indirect damages include certain losses which result from flooding even though the property involved was not flooded. Some examples of such indirect damages follow. An electric power plant is flooded so that power is no longer produced and spoilage takes place in freezers and refrigerators operated by electricity. A bridge is washed out and traffic is forced to detour a considerable distance. A flood causes interruption in the feeding regimen of a livestock producer and, although his livestock were not in the flood, the upset slows down the rate of gain and causes extra expense before they are marketable.

In estimating indirect damage, care must be taken to avoid double counting. For example, a house may be flooded and the family living there may lose its clothing. This loss is a direct damage, but the value of substitute clothing supplied by a relief agency would not be an additional indirect damage.

Information on indirect damages usually is more difficult to obtain than on direct damage. Although some data will be gathered during the course of ordinary damage interviews, it seldom will be complete. Indirect damages are of so many different kinds that neither the economist nor the respondent may think of all possibilities. Experience has indicated that indirect damage often may be expressed as a percentage of the direct. The information from the schedules generally will be sufficient to indicate the portion of the suggested range that is applicable. Considerable latitude may be allowed for special cases. The following percentages of direct damages are suggested for use in estimating indirect damages.

Type of Direct Damage	Percentage Range
Agricultural 1/	5 - 10
Residential	10 - 15
Commercial and Industrial	15 - 20
Highways, Bridges and Railroads	15 - 25
Utilities	15 - 20

1/ The percentage probably will be much higher when irrigation and drainage facilities are damaged. The indirect damage should be determined on a case basis when these facilities are involved.

A special situation often exists in the case of residential housing. In many cities low cost housing tends to occupy the flood plain. When this is true, a special study of indirect damage is needed as the usual relationship between direct and indirect damage may not hold.

In an area exceptionally sensitive to flooding, evacuation may take place as soon as a flood threat arises. Then indirect damage would accrue even though no flooding actually occurred. When a residence is flooded, the direct damage curve generally flattens as greater depths of water are reached. In addition, the indirect damage usually becomes less in proportion to the direct.

IV. BENEFIT EVALUATION

Thus far in this chapter the principles of damage appraisals have been presented and basic appraisal methods have been described. Damage appraisal usually is essential in flood prevention in order that benefits for economic justification may be determined. The determination of flood prevention benefits is described briefly in this section of the chapter.

A. Off-Site Benefits

In general, off-site benefits may be considered as accruing to someone who has no control over the source of damage. In the case of a critical sediment producing area, off-site benefits may result from control of the sediment output in the form of a decrease in rate of channel filling and the resulting flooding downstream. A floodwater retarding structure will create off-site benefits from reduced

flooding on the downstream flood plain. Off-site benefits usually are the principal type of benefit to be derived from flood prevention measures.

1. Reductions in Damage

Flood damages are reduced by a reduction of discharge or an increased channel capacity, which in turn reduces the area, duration, and depth of flooding or the sediment load carried for downstream deposition. Evaluation requires the determination of the damages under non-project conditions and those remaining after land treatment and successive increments of structural measures. The difference between the damage before and after installation of any segment of the project constitutes the benefit from damage reduction creditable to that segment.

In addition to reductions in ordinary physical damage, consideration should be given to the possibility that flood prevention measures sometimes will reduce the cost of operation and maintenance or lengthen the life of proposed or existing facilities. For example, a heavy sediment load in a stream may cause such extensive channel filling that it requires cleaning out at frequent intervals. In this case, benefits could arise from reduction in the cost of cleaning out the channel and would constitute a form of damage reduction benefits.

In the Frequency Method the modified discharge-frequency curve, prepared by the hydrologist, will enable the economist to prepare a modified damage-frequency curve to compare with the non-project or original damage-frequency curve to determine benefits. Modified curves prepared by the economist and hydrologist are necessary for each kind or combination of measures being evaluated.

The same principle is involved in the Historical Series Method. The total difference in damages over the evaluation period, adjusted for recurrence, is divided by the number of years in the series to determine average annual damages. This is required for each kind or combination of measures being evaluated for comparison with the non-project or original damage.

Benefits from reduction in damage as a result of flood prevention measures generally begin to accrue as soon as the measures are installed and need no discounting for time lag. The chief exceptions will be when areas are restored to their former productivity. If there is land damage from sediment deposition or flood plain scour, time will be required for recovery. Likewise, if frequent flooding has caused a shift to land use less susceptible to flood damage, operators of flood plain lands can be expected to wait until they can judge the effectiveness of their protection before they restore the area to its former use. Proper discounting should be considered for such benefits when significant time lags are involved.

When reduction in land damage is used as a benefit, appropriate adjustments in estimates of other types of damage should be made.

As an example, when flood plain land is destroyed through stream bank erosion, the estimate of crop and pasture damage during the life of the project must be reduced to take into account the progressively smaller area that will remain to sustain damage.

A technical problem that arises in the evaluation of the benefits from waterflow control measures is the collaboration between the hydrologist and the economist in determining the acreages involved. The flood routing to determine damages under non-project conditions and after land treatment measures have been installed may be done before floodwater retarding structure sites have been determined. When these sites have been located finally, it may be that part of the flood plain on which previous routing has been made will be included within the pool area of the structure. Unless adjustments are made, the difference between damages before and after project installation would include the damage within the pool area as a project benefit. Adjustments of a similar nature also will be needed when channel improvement or floodways are planned and their benefits are evaluated.

2. Future Development in the Absence of a Project

As discussed earlier in this chapter, project evaluation requires a comparison of conditions which would exist over the project life in the absence of the project with those that can be expected with the project in operation. In nearly every project, therefore, the damageable value base from which evaluation is to be made will be different from the present situation.

The most common approach to this problem is to estimate the eventual degree of change, the period over which the change will occur, and assume that the change will take place uniformly over time. This will provide an annual increment of change which can be discounted to present worth and used to adjust the present to average future conditions.

It is worth noting that the use of a simple average of the existing and eventual values for this purpose is unsound because deferred values are worth less than similar values at hand. Consequently, when damageable values are increasing, the greatest value will be at the end of the time period and will receive the heaviest discount. The average annual equivalent values after discounting, then will be less than the simple average of values. The reverse is true if damageable values are declining. (For a more complete discussion, see Appendix A).

In an expanding economy it can be expected that values generally will increase. Improving technology and the pressure from increasing population will encourage increased agricultural production per unit of area. Values in existing developments will increase because of new products and a higher standard of living. Urbanization will cause urban areas and the suburban fringes to encroach upon areas now in agriculture. Although this will be the usual situation, there will be cases where values will decline. Changes in diet and cost-price

relationships may encourage shifts of some areas from cash crop to livestock production. Small rural communities may decline in importance as improved travel makes larger centers more accessible. Consequently adjustments to account for future development may involve either increases or declines in damageable values.

Changes in development without a project should not be confused with the enhancement-type benefits caused by the project, described in Chapter 4.

3. Increased Income

The flood hazard often prevents the highest use of resources. Once the hazard is removed, these resources probably will be used more effectively. For example, a flood plain pasture is little used because of the hazard to livestock. So-called "catch crops" are being grown instead of high value crops in an effort to avoid the season of worst flooding. These are examples of situations where protection may allow land to remain in its original use but income will be increased through more effective use of resources.

Protection also may allow land to be converted to higher, more productive uses. Perhaps brush will be cleared and a frequently flooded field will be converted to cropland after effective protection. Or unused land in an urban area will be shifted to industrial or other use.

Changes of these types usually will take place only after some lag in time. Benefits calculated therefrom should be discounted accordingly.

The increased net income resulting from such changes is a benefit derived from flood prevention. Associated costs required to make such changes possible should be deducted from the gross increase in income.

Special consideration should be given to certain situations in evaluating enhancement-type benefits. Included among these are the following:

a. Sometimes flood plain production will be increased through moving crops from upland areas less suited to their production down to the fertile flood plain. The upland area is shifted to a less intensive use. When this is done, the increased income from the flood plain may be offset partially by reduced income in the upland area.

b. In an urban area there may be expansion of industry, business, or residential developments into the flood plain after protection. Had there been no protection, the total expansion might have been about the same but it would have been into other areas, perhaps the agricultural fringe around the city. Here the enhancement benefit would be only from the advantage the flood plain would have over the alternative areas in such things as economy of development or use.

c. Special care must be taken to distinguish between enhancement resulting from the project and future development that will take place without the project, because of the possibility of double counting. Often a separation by geographical areas where only one or the other is anticipated will be helpful. Evaluation of these enhancement-type benefits is discussed in some detail in Chapter 4.

4. Remaining Damage to Higher Values

An attempt to provide complete flood protection ordinarily will not be economic. It may even be physically impossible. If the project is installed and the flood plain is used more intensively as a result, it can be expected that remaining floods will cause more damage than they would under the original land use. The increased income from restoration, intensification or changed land use should be adjusted to account for this condition.

Adjustments may be made either for the frequency or the historical methods by using the new damageable values and the flooding from the remaining events. Experience will indicate appropriate shortcuts that can be used to fit a given situation.

B. On-site Benefits

On-site benefits are those that accrue at the general location of the control measure.

Many land stabilization measures produce on-site as well as off-site benefits. Vegetative plantings on critical sediment source areas may increase the net return from cropping, grazing, or wildlife production. Stabilization may preserve the full value of land that otherwise would be encroached upon by gullies. Sometimes installation of land treatment measures would not be feasible without first installing measures for stabilizing gullies. Increased net returns that occur on the drainage area of the structures over the amount that could be obtained without structural stabilization measures are creditable to the structural measures. Such benefits may be largely in the form of reduced crop or livestock income losses or increased crop or livestock returns. Details of the evaluation of land damage from erosion and sediment deposition may be found in Chapter 5. The cost of the necessary land treatment measures, when their installation is made possible because of the stabilization measures, should be handled as an associated cost.

Such waterflow control measures as detention-type terraces and water-spreading devices may give important on-site benefits. These benefits may be measured through an approach similar to that described above for land stabilization measures.

On-site benefits may be available within the site of a floodwater retarding structure. Such benefits may accrue from fish culture,

recreation, and use of the sediment pool for stockwater, irrigation or domestic water supply. Evaluation of the benefits from other uses should take into account the fact that the sediment pool is designed to store sediment and its ability to furnish incidental benefit will decline through the project life. Any benefits claimed should be discounted on this account. Evaluation of benefits when used incidentally for irrigation should recognize the fact that the sediment pool cannot be expected to furnish a fully dependable water supply for this purpose. Evaluation of on-site benefits from incidental use of floodwater retarding structures should take cognizance of State laws regarding water use. For example, in some states prior appropriation has been made for certain downstream uses and provision has to be made for drainage of the sediment pool on demand. Under these conditions no firm on-site benefits can be claimed for its use.

V. COSTS

Economic analysis involves the comparison of the costs of a project with the benefits which it produces. Both are reduced to equivalent time values. This may be done either by capitalization of periodic benefits and costs to place them on the same basis as capital outlays, or by converting capital sums to their annual equivalent through amortization. The latter is the usual procedure.

Costs may be divided into two main groups - project costs and associated costs.

A. Project Costs

These costs include all costs incurred in project installation, operation and maintenance which are to be compared with project benefits.

1. Installation Costs

Included in the project installation costs are all costs of construction, including design, engineering, inspection and an allowance for contingency. The value of lands, easements, rights-of-way, and the cost of relocating facilities that must be moved because of the installation are included.

At times sites may be purchased. In this case the funds expended are a measure of the cost. In other cases, the estimate of value by the local organization, with the concurrence of the Service, will be used for determining the value of the site. Even when sites are donated, there usually is a cost to someone although this may be offset in whole or in part by incidental benefits from the new use of the site. Some of the considerations inherent in site cost evaluation are discussed in Chapter 13, Land, Easements, and Rights-of-Way.

Installation costs are capital expenditures incurred during project installation. As such, unless there is a prolonged installation

period, current price levels should be used. In case any one structure in a project will require a prolonged period (over two years) for its installation, interest on the average investment during this period becomes a part of the installation cost. Ordinarily this will not be applicable to small watershed projects. For comparison with project benefits, installation costs are amortized over the project life. Although not usually applicable to flood prevention projects, if salvage values remain after the end of the project life appropriate deductions in costs may be considered.

2. Operation and Maintenance Costs

The cost of maintaining works of improvement in such a condition that they will deliver the full benefit for which they were designed is another cost component. Maintenance costs may vary from year to year, however, in economic appraisal the best estimate that can be made of average costs over the period of analysis should be used. Normally, the longer the project life, the more should be allowed for project maintenance.

Sometimes a project will have facilities which must be replaced during the life of the project. The original cost of such facilities will be included in the project installation cost and amortized over the project life. Provision for replacement will be made by inclusion of sufficient funds for this purpose in the maintenance cost of the project.

Another item of annual cost is operation of the works of improvement. When automatically operating measures, such as drop inlets or floodwater retarding structures, are concerned operating costs are generally nil. Such costs should be considered when manually operated gates and similar types of equipment are involved.

3. Induced Costs

These costs include all uncompensated adverse effects in goods and services caused by the construction or operation of a project.

A typical example would be the value of the loss in production on lands taken for project purposes that is in excess of the payment therefor or the estimated easement value. Thus if the estimated amortized easement value is $5,000 but the loss in agricultural production is $6,000 annually, the difference, $1,000 annually, is another economic cost of the project and should be included with project costs.

In calculating the loss of net income in agricultural areas to be used for project purposes, items to consider include: non-project land uses and yields compared with those attained with the project, flood damage to non-project uses, and taxes and overhead costs. Among the types of measures where these items may be significant are: fencing and exclusion of use in critical sediment source areas; the pools, embankment, and spillway of floodwater retarding structures; the channel and spoil disposal areas for channel improvement, etc.

It is not likely that flood prevention measures normally will be so located that they will displace production from industrial, mining or urban areas. If they are so located, adequate accounting should be made of the production lost.

If channel improvement or other similar waterflow control measures are terminated at a point where possible floodwater, sediment or erosion damages may be induced downstream, such damages should be considered as induced by the project. Sometimes flowage easements may provide a financial measure of these costs. If such costs are not adequate, the excess would be a form of "Other Economic Costs" of the project.

In some cases project installation may induce damage to fish and wildlife resources.

Whenever induced damages are caused, either measures should be incorporated into the project to alleviate these damages, or they should be counted as a tangible or intangible cost of the project.

B. Associated Costs

Associated costs may be considered as the value of goods and services needed over and above project costs to make the immediate products of the project available for use or sale. They are usually considered as deductions from benefits.

In flood prevention, associated costs are involved chiefly in calculating benefits from changed land use. Associated costs connected with changed use of the land, such as provision of streets and utilities in urban areas, or conversion from pasture to cropland, clearing woods, farm drainage and the like on agricultural land, are amortized and deducted from the increased income. It is possible that additional barns, granaries and equipment may be needed to handle the additional production. Thus associated costs may include an item for increased taxes and overhead. The increase in the cost of farm operations involved in crop production forms another item of associated costs for deduction from the increase in gross income.

When land treatment measures are required to realize the benefits from structural measures, the cost of the necessary land treatment becomes an associated cost. Such a case might arise if flood protection enables a farmer to level his land and install on-farm drainage or irrigation. Here land leveling and the on-farm drainage or irrigation systems would become associated costs.

The treatment of the direct costs of crop production is a little different in damage analysis. When a crop is destroyed by a flood, the full cost of operations yet to be performed is subtracted from the damage as expense not incurred. If the crop is flooded early and replanting is necessary, the full cost of the added operations is

included in the damage estimate. The term "full cost" includes the value of unpaid family labor and interest and depreciation on machinery as well as out-of-pocket cash costs.

Although associated costs do not appear in the benefit-cost ratio, their careful appraisal is most important. Because they are deducted from the gross benefit, they determine the size of the benefit used in economic analysis. They have almost equal importance as a supplementary economic tool in determining whether appraisals of damage and benefits are realistic. For example, the spread between gross income and associated costs is of high importance in estimating the amount of damage a farmer will take before letting his flood plain lands lie idle, and the degree of protection he will require before he intensifies his land use.

Alfalfa - April through September

Pasture - April through September

Sugar Beets - April through September

Corn Silage - May 15 to September 15

Small Grain - May to July 15

Composite acre water requirement:

Crop	Land Use	April	May	June	July	August	Sept.	
Corn S.	10		.15	.27	.48	.47	.15	
Sugar B.	20	.40	.49	.40	.80	.79	.51	
Sm. Grain	10		.27	.23	.22			
Pasture	20	.44	.55	.47	.87	.86	.56	
Alfalfa	40	.96	1.21	1.08	1.91	1.86	1.23	
Total	100	1.80	2.67	2.45	4.28	3.98	2.45	17.63

Value added per inch of irrigation water supplied

113.90 ÷ 17.63 = $6.46

Value added per month

April	May	June	July	August	Sept.	Total
$11.63	$17.25	$15.83	$27.65	$25.71	$15.83	$113.90

Value added per day

.39	.56	.53	.89	.83	.53

Damage per composite acre from a 15 day break in:

5.85	8.40	7.95	13.35	12.45	7.95

Weighted damage per composite acre:

Month	Damage		Monthly Storm Distribution		
April	5.85	x	5	=	
May	8.40	x	22	=	
June	7.95	x	33	=	
July	13.35	x	17	=	
August	12.45	x	10	=	
September	7.95	x	5	=	
Total					$ 8.68

This $8.68 is the weighted damage per composite acre per break. The average annual damage from delay in water delivery is equal to number of acres served times damage per acre times the storm frequency required to cause the canal to fail. (This assumes that the breaks from more infrequent storms do not require longer to repair.)

If in the above example this canal serves 1500 acres, the average annual damages would then be:

1500 acres x $8.68 x 6% = $781.20

RESIDENCE FLOOD DAMAGE TABLE

Current Dollar Value	Items	Total Value of Furniture	Basement Damage	Dollar Damage at Depth Flooded Over First Floor																		
				.0-.4'	.5'-1.4'	1.5'-2.0'	2.5'	3.0'	3.5'	4.0'	4.5'	5.0'	5.5'	6.0'	6.5'	7.0'	7.5'	8.0'	8.5'	9.0'	9.5'	10'
$1,000	Floors & Walls			$ 75	$ 85	$ 95	$ 105	$ 115	$ 125	$ 135	$ 140	$ 150	$ 160	$ 170	$ 180	$ 190	$ 200	$ 250	$ 250	$ 250	$ 250	$ 250
	Furniture	$ 330		165	215	250	250	250	260	265	275	280	280	280	280	280	280	280	280	280	280	280
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		$ 110	400	460	505	520	530	555	570	590	605	620	630	645	655	670	720	725	725	730	730
1,500	Floors & Walls			110	125	140	155	170	185	200	210	225	240	255	270	285	300	375	375	375	375	375
	Furniture	495		240	310	360	365	370	385	395	410	420	420	420	420	420	420	420	420	420	420	420
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		120	520	605	670	695	715	750	775	805	830	850	865	885	900	920	995	1000	1000	1005	1005
2,000	Floors & Walls			150	170	190	210	225	245	265	285	305	325	340	360	380	400	500	500	500	500	500
	Furniture	660		315	405	475	485	495	515	530	545	560	560	560	560	560	560	560	560	560	560	560
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		130	645	755	845	880	905	950	985	1025	1060	1085	1100	1125	1145	1170	1270	1275	1275	1280	1280
2,500	Floors & Walls			185	210	235	260	280	305	330	355	380	405	430	450	475	500	625	625	625	625	625
	Furniture	830		380	500	590	605	620	645	665	685	705	705	705	705	705	705	705	705	705	705	705
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		140	755	900	1015	1060	1095	1150	1195	1245	1290	1320	1345	1370	1395	1425	1550	1555	1555	1560	1560
3,000	Floors & Walls			220	250	280	310	335	365	395	425	455	485	510	540	570	600	750	750	750	750	750
	Furniture	1000		450	600	700	725	750	750	800	825	850	850	850	850	850	850	850	850	850	850	850
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		150	870	1050	1180	1240	1290	1325	1405	1465	1520	1555	1580	1615	1645	1680	1830	1835	1835	1840	1840
3,500	Floors & Walls			255	290	325	360	390	425	460	495	530	565	595	630	665	700	875	875	875	875	875
	Furniture	1150		505	670	785	825	865	895	920	950	980	980	980	980	980	980	980	980	980	980	980
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		160	970	1170	1320	1400	1470	1540	1600	1670	1735	1775	1805	1845	1880	1920	2095	2100	2100	2105	2105
4,000	Floors & Walls			290	330	370	410	445	485	525	565	605	645	680	720	760	800	1000	1000	1000	1000	1000
	Furniture	1300		560	740	870	925	975	1010	1040	1075	1105	1105	1105	1105	1105	1105	1105	1105	1105	1105	1105
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		165	1065	1285	1455	1555	1640	1720	1790	1870	1940	1985	2020	2065	2105	2150	2350	2355	2355	2360	2360
4,500	Floors & Walls			330	375	420	460	505	550	595	635	680	725	770	810	855	900	1125	1125	1125	1125	1125
	Furniture	1475		620	825	960	1035	1105	1145	1180	1220	1255	1255	1255	1255	1255	1255	1255	1255	1255	1255	1255
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		175	1175	1425	1605	1725	1840	1930	2010	2095	2175	2225	2270	2315	2360	2410	2635	2640	2640	2645	2645
5,000	Floors & Walls			375	425	470	520	570	615	665	710	760	810	860	905	950	1000	1250	1250	1250	1250	1250
	Furniture	1650		680	910	1050	1145	1240	1280	1320	1365	1405	1405	1405	1405	1405	1405	1405	1405	1405	1405	1405
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		185	1290	1570	1755	1905	2050	2140	2230	2325	2415	2470	2520	2570	2615	2670	2720	2725	2725	2730	2730
5,500	Floors & Walls			410	465	515	560	625	675	730	780	835	890	940	995	1045	1100	1375	1375	1375	1375	1375
	Furniture	1825		730	985	1130	1250	1370	1415	1460	1505	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
	Lawn			55	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90	95	95
	TOTAL w/Basement		190	1385	1695	1890	2070	2245	2345	2445	2545	2645	2705	2755	2815	2865	2925	3200	3205	3205	3210	3210
6,000	Floors & Walls			440	500	555	615	675	735	790	850	910	965	1025	1085	1140	1200	1500	1500	1500	1500	1500
	Furniture	2000		780	1060	1210	1355	1500	1550	1600	1650	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
	Lawn			60	60	60	65	65	70	70	75	75	80	80	85	85	90	90	95	95	100	100
	TOTAL w/Basement		200	1480	1820	2025	2235	2440	2555	2660	2775	2885	2945	3005	3070	3125	3190	3490	3495	3495	3500	3500

RESIDENCE FLOOD DAMAGE TABLE (Contd.)

Current Dollar Value	Items	Total Value of Furniture	Basement Damage	Dollar Damage at Depth Flooded Over First Floor																		
				.0'-.4'	.5'-1.4'	1.5'-2.0'	2.5'	3.0'	3.5'	4.0'	4.5'	5.0'	5.5'	6.0'	6.5'	7.0'	7.5'	8.0'	8.5'	9.0'	9.5'	10'
6,500	Floors & Walls	2150		475	540	600	665	730	795	855	920	985	1045	1110	1175	1235	1300	1625	1625	1625	1625	1625
	Furniture			815	1105	1270	1445	1615	1670	1720	1775	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830
	Lawn			65	65	65	70	70	75	75	80	80	85	85	90	90	95	95	100	100	105	105
	TOTAL w/Basement		210	1565	1920	2145	2390	2625	2750	2860	2985	3105	3170	3235	3305	3365	3435	3760	3765	3765	3770	3770
7,000	Floors & Walls	2300		510	580	645	715	785	855	920	990	1060	1125	1195	1265	1330	1400	1750	1750	1750	1750	1750
	Furniture			850	1150	1330	1530	1725	1785	1840	1900	1955	1955	1955	1955	1955	1955	1955	1955	1955	1955	1955
	Lawn			70	70	70	75	75	80	80	85	85	90	90	95	95	100	100	105	105	110	110
	TOTAL w/Basement		225	1655	2025	2270	2545	2810	2945	3065	3200	3325	3395	3465	3540	3605	3680	4030	4035	4035	4040	4040
8,000	Floors & Walls	2650		580	660	735	815	895	975	1050	1130	1210	1285	1365	1445	1520	1600	2000	2000	2000	2000	2000
	Furniture			925	1270	1450	1720	1990	2055	2120	2190	2255	2255	2255	2255	2255	2255	2255	2255	2255	2255	2255
	Lawn			80	80	80	85	85	90	90	95	95	100	100	105	105	110	110	115	115	120	120
	TOTAL w/Basement		250	1835	2260	2515	2870	3220	3370	3510	3665	3810	3890	3970	4055	4130	4215	4615	4620	4620	4625	4625
9,000	Floors & Walls	3000		640	730	820	910	995	1085	1175	1265	1355	1445	1535	1620	1710	1800	2250	2250	2250	2250	2250
	Furniture			1020	1380	1560	1905	2250	2325	2400	2475	2550	2550	2550	2550	2550	2550	2550	2550	2550	2550	2550
	Lawn			90	90	90	95	95	100	100	105	105	110	110	115	115	120	120	125	125	130	130
	TOTAL w/Basement		275	2025	2475	2745	3185	3615	3785	3950	4120	4285	4380	4470	4560	4650	4745	5195	5200	5200	5205	5205
0,000	Floors & Walls	3300		685	785	890	990	1090	1190	1290	1395	1495	1595	1695	1800	1900	2000	2500	2500	2500	2500	2500
	Furniture			1090	1480	1680	2080	2475	2560	2640	2725	2805	2805	2805	2805	2805	2805	2805	2805	2805	2805	2805
	Lawn			100	100	100	105	105	110	110	115	115	120	120	125	125	130	130	135	135	140	140
	TOTAL w/Basement		305	2180	2670	2975	3480	3975	4165	4345	4540	4720	4825	4925	5035	5135	5240	5740	5745	5745	5750	5750
1,000	Floors & Walls	3650		735	850	960	1075	1185	1300	1410	1525	1635	1750	1860	1975	2085	2200	2750	2750	2750	2750	2750
	Furniture			1170	1610	1820	2280	2740	2830	2920	3015	3105	3105	3105	3105	3105	3105	3105	3105	3105	3105	3105
	Lawn			110	110	110	115	115	120	120	125	125	130	130	135	135	140	140	145	145	150	150
	TOTAL w/Basement		345	2360	2915	3235	3815	4385	4595	4795	5010	5210	5330	5440	5560	5670	5790	6340	6345	6345	6350	6350
2,000	Floors & Walls	4000		775	900	1025	1150	1275	1400	1525	1650	1775	1900	2025	2150	2275	2400	3000	3000	3000	3000	3000
	Furniture			1240	1720	1960	2480	3000	3100	3200	3300	3400	3400	3400	3400	3400	3400	3400	3400	3400	3400	3400
	Lawn			120	120	120	125	125	130	130	135	135	140	140	145	145	150	150	155	155	160	160
	TOTAL w/Basement		390	2525	3130	3495	4145	4790	5020	5245	5475	5700	5830	5955	6085	6210	6340	6940	6945	6945	6950	6950
3,000	Floors & Walls	4300		820	955	1095	1230	1370	1505	1640	1780	1915	2050	2190	2325	2465	2600	3250	3250	3250	3250	3250
	Furniture			1290	1805	2065	2645	3225	3335	3440	3550	3655	3655	3655	3655	3655	3655	3655	3655	3655	3655	3655
	Lawn			130	130	130	135	135	140	140	145	145	150	150	155	155	160	160	165	165	170	170
	TOTAL w/Basement		425	2665	3315	3715	4435	5155	5405	5645	5900	6140	6280	6420	6560	6700	6840	7490	7495	7495	7500	7500
,000	Floors & Walls	4600		860	1010	1160	1310	1455	1605	1755	1905	2055	2205	2350	2500	2650	2800	3500	3500	3500	3500	3500
	Furniture			1330	1890	2160	2805	3450	3565	3680	3795	3910	3910	3910	3910	3910	3910	3910	3910	3910	3910	3910
	Lawn			140	140	140	145	145	150	150	155	155	160	160	165	165	170	170	175	175	180	180
	TOTAL w/Basement		460	2790	3500	3920	4720	5510	5780	6045	6315	6580	6735	6880	7035	7185	7340	8040	8045	8045	8050	8050
,000	Floors & Walls	4950		900	1060	1225	1385	1545	1710	1870	2030	2190	2355	2515	2675	2840	3000	3750	3750	3750	3750	3750
	Furniture			1390	1980	2280	3000	3715	3840	3960	4085	4210	4210	4210	4210	4210	4210	4210	4210	4210	4210	4210
	Lawn			150	150	150	155	155	160	160	165	165	170	170	175	175	180	180	185	185	190	190
	TOTAL w/Basement		505	2945	3695	4160	5045	5920	6215	6495	6785	7070	7240	7400	7565	7730	7895	8645	8650	8650	8655	8655
,000	Floors & Walls	5280		960	1140	1310	1470	1650	1820	2000	2160	2340	2510	2690	2850	3020	3200	4000	4000	4000	4000	4000
	Furniture			1490	2110	2432	3200	3970	4100	4220	4350	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500
	Lawn			160	160	160	160	160	180	180	180	180	180	180	190	190	190	190	190	190	210	210
	TOTAL w/Basement		540	3150	3950	4442	5370	6320	6640	6940	7230	7560	7730	7910	8080	8250	8430	9230	9230	9230	9250	9250

RESIDENCE FLOOD DAMAGE TABLE (Contd.)

Current Dollar Value	Items	Total Value of Furniture	Basement Damage	Dollar Damage at Depth Flooded Over First Floor																		
				.0'-.4'	.5'-1.4'	1.5'-2.0'	2.5'	3.0'	3.5'	4.0'	4.5'	5.0'	5.5'	6.0'	6.5'	7.0'	7.5'	8.0'	8.5'	9.0'	9.5'	10'
17,000	Floors & Walls	5610		1020	1210	1390	1560	1750	1940	2120	2300	2480	2670	2860	3030	3210	3400	4250	4250	4250	4250	4250
	Furniture			1580	2240	2580	3400	4220	4350	4490	4620	4780	4780	4780	4780	4780	4780	4780	4780	4780	4780	4780
	Lawn			170	170	170	170	170	190	190	190	190	190	190	200	200	200	200	200	200	220	220
	TOTAL w/Basement		580	3350	4200	4720	5710	6720	7060	7380	7690	8030	8220	8410	8590	8770	8960	9810	9810	9810	9830	9830
18,000	Floors & Walls	5940		1080	1280	1480	1660	1850	2050	2250	2430	2630	2830	3020	3200	3400	3600	4500	4500	4500	4500	4500
	Furniture			1670	2380	2740	3600	4460	4610	4750	4900	5060	5060	5060	5060	5060	5060	5060	5060	5060	5060	5060
	Lawn			180	180	180	180	180	200	200	200	200	200	200	220	220	220	220	220	220	230	230
	TOTAL w/Basement		610	3540	4450	5010	6050	7100	7470	7810	8140	8500	8700	8890	9090	9290	9490	10390	10390	10390	10400	10400
19,000	Floors & Walls	6270		1140	1350	1560	1750	1960	2170	2380	2560	2770	2980	3190	3380	3590	3800	4750	4750	4750	4750	4750
	Furniture			1770	2510	2890	3800	4710	4860	5020	5170	5340	5340	5340	5340	5340	5340	5340	5340	5340	5340	5340
	Lawn			190	190	190	190	190	210	210	210	210	210	210	230	230	230	230	230	230	250	250
	TOTAL w/Basement		650	3750	4700	5290	6390	7510	7890	8260	8590	8970	9180	9390	9600	9810	10020	10970	10970	10970	10990	10990
20,000	Floors & Walls	6600		1200	1420	1640	1840	2060	2280	2500	2700	2920	3140	3360	3560	3780	4000	5000	5000	5000	5000	5000
	Furniture			1860	2640	3040	4000	4960	5120	5280	5440	5620	5620	5620	5620	5620	5620	5620	5620	5620	5620	5620
	Lawn			200	200	200	200	200	220	220	220	220	220	220	240	240	240	240	240	240	260	260
	TOTAL w/Basement		680	3940	4940	5560	6720	7900	8200	8480	9040	9440	9660	9880	10100	10320	10540	11540	11540	11540	11560	11560
21,000	Floors & Walls	6930		1260	1490	1720	1930	2160	2390	2625	2840	3070	3300	3530	3740	3970	4200	5250	5250	5250	5250	5250
	Furniture			1950	2770	3190	4200	5210	5380	5540	5710	5900	5900	5900	5900	5900	5900	5900	5900	5900	5900	5900
	Lawn			210	210	210	210	210	230	230	230	230	230	230	250	250	250	250	250	250	270	270
	TOTAL w/Basement		710	4130	5180	5830	7050	8290	8710	9105	9490	9910	10140	10370	10600	10830	11060	12110	12110	12110	12130	12130
22,000	Floors & Walls	7260		1320	1560	1800	2020	2270	2510	2750	2970	3210	3450	3700	3920	4160	4400	5500	5500	5500	5500	5500
	Furniture			2050	2900	3340	4400	5460	5630	5810	5980	6180	6180	6180	6180	6180	6180	6180	6180	6180	6180	6180
	Lawn			220	220	220	220	220	240	240	240	240	240	240	260	260	260	260	260	260	290	290
	TOTAL w/Basement		750	4340	5430	6110	7390	8700	9130	9550	9940	10380	10620	10870	11110	11350	11590	12690	12690	12690	12720	12720
23,000	Floors & Walls	7590		1380	1630	1890	2120	2370	2620	2875	3100	3360	3610	3860	4090	4350	4600	5750	5750	5750	5750	5750
	Furniture			2140	3040	3500	4600	5700	5890	6070	6260	6460	6460	6460	6460	6460	6460	6460	6460	6460	6460	6460
	Lawn			230	230	230	230	230	250	250	250	250	250	250	280	280	280	280	280	280	300	300
	TOTAL w/Basement		780	4530	5680	6400	7730	9080	9540	9975	10390	10850	11100	11350	11610	11870	12120	13270	13270	13270	13290	13290
24,000	Floors & Walls	7920		1440	1700	1970	2210	2470	2740	3000	3240	3500	3770	4030	4270	4540	4800	6000	6000	6000	6000	6000
	Furniture			2230	3170	3650	4800	5950	6140	6340	6530	6740	6740	6740	6740	6740	6740	6740	6740	6740	6740	6740
	Lawn			240	240	240	240	240	260	260	260	260	260	260	290	290	290	290	290	290	310	310
	TOTAL w/Basement		820	4730	5930	6680	8070	9480	9960	10420	10850	11320	11590	11850	12120	12390	12650	13850	13850	13850	13870	13870
25,000	Floors & Walls	8250		1500	1780	2050	2300	2580	2850	3120	3380	3650	3920	4200	4450	4720	5000	6250	6250	6250	6250	6250
	Furniture			2320	3300	3800	5000	6200	6400	6600	6800	7020	7020	7020	7020	7020	7020	7020	7020	7020	7020	7020
	Lawn			250	250	250	250	250	270	270	270	270	270	270	300	300	300	300	300	300	320	320
	TOTAL w/Basement		850	4920	6180	6950	8400	9880	10370	10840	11300	11790	12060	12340	12620	12890	13170	14420	14420	14420	14440	14440
26,000	Floors & Walls	8580		1560	1850	2130	2390	2680	2960	3250	3510	3800	4080	4370	4630	4910	5200	6500	6500	6500	6500	6500
	Furniture			2420	3430	3950	5200	6450	6660	6860	7070	7310	7310	7310	7310	7310	7310	7310	7310	7310	7310	7310
	Lawn			260	260	260	260	260	290	290	290	290	290	290	310	310	310	310	310	310	340	340
	TOTAL w/Basement		880	5120	6420	7220	8730	10270	10790	11280	11750	12280	12560	12850	13130	13410	13700	15000	15000	15000	15030	15030
27,000	Floors & Walls	8910		1620	1920	2210	2430	2780	3080	3380	3640	3940	4240	4540	4810	5100	5400	6750	6750	6750	6750	6750
	Furniture			2510	3560	4100	5400	6700	6910	7130	7340	7590	7590	7590	7590	7590	7590	7590	7590	7590	7590	7590
	Lawn			270	270	270	270	270	300	300	300	300	300	300	320	320	320	320	320	320	350	350
	TOTAL w/Basement		920	5320	6670	7500	9070	10670	11210	11730	12200	12750	13050	13350	13640	13930	14230	15580	15580	15580	15610	15610

CHAPTER 3

FLOODWATER DAMAGES AND BENEFITS

This chapter describes the appraisal of floodwater damages and benefits. It first outlines the evaluation background. Then it describes general methods of determining average annual floodwater damage. It discusses considerations in appraising most of the different types of floodwater damage such as agricultural, urban residential, industrial and commercial; and transportation. The final sections of the chapter consider flood prevention benefit-cost evaluation.

For the most part the discussion is confined to the application of economic principles to the problem at hand, and general methods of accumulating and analyzing data for evaluation purposes. No attempt is made to prescribe step-by-step procedural details. The diversity of conditions found would cause such an approach for nation-wide application to be more harmful than beneficial.

I. GENERAL CONSIDERATIONS IN DAMAGE APPRAISAL

Damage appraisal for project evaluation involves a comparison of the damage that can be expected without the project and that which will occur after the project is installed. Proper appraisal requires a projection of physical and economic conditions during the life of the project. The present condition is merely a convenient benchmark from which to estimate future conditions without and with the project. This projection into the future is most difficult.

A few of the problems often encountered in making these projections are outlined below. (1) Perhaps sediment is filling the channel so that if nothing is done flooding will become more severe. It may become so serious that cultivation of most, or all, of the flood plain will be abandoned. (2) On the other hand, there may be channel degradation or bank cutting which will increase the size of the channel if nothing is done. Then flooding can be expected to become less frequent and severe, or land may be lost from production. When either of these conditions exist, the economist is dependent upon both the geologist and hydrologist for projections of the physical conditions. (3) Agricultural trends must be considered. It may be that the type of agriculture is changing and is affecting the land use pattern. Technological progress in agriculture is causing marked increases in yields. The economist must consider how these advances will affect crop and pasture yields during the life of the project. Even though the project were not installed, technological progress can be expected. Changes brought about by improved technology should not be confused with those caused by recovery from land damage as described in Chapter 5. They also should be kept separate from yield increases that arise from the fact that greater advantage can be taken of technological improvement if flood risks are reduced. Increases of this type

are described in Chapter 4. (4) Non-agricultural values are increasing constantly. They may take the form of residential or industrial developments encroaching upon the flood plain. Or they may arise merely from higher values attached to existing development. For example, the constantly rising standard of living has resulted in the average residence containing appliances that were unknown 20 years ago.

Many different methods may be used in making projections of future conditions. The method used will depend upon the given situation. Mere extrapolation of existing trends generally is not sufficient. The economist will need to gather and evaluate sufficient background data to form a basis for sound projections.

II. MAJOR METHODS OF CALCULATING AVERAGE ANNUAL DAMAGE

The measurement of floodwater damages and the benefit from reduction of damage usually is done by one of four methods. Each of the methods may be specially applicable to particular situations. This section describes each briefly.

A. Frequency Method

The frequency method used in flood damage appraisal involves the establishment of relationships between the physical and economic flood characteristics and the probable frequency of flood occurrence.

The physical appraisal involves establishing the relationships of the physical characteristics of floods to frequency of their occurrence. These associations, generally expressed by means of graphs, include the following:

1. Runoff related to frequency of occurrence -- obtained either through conversion of rainfall to runoff, or from runoff as measured by stream gages.

2. Runoff versus discharge (cfs).

*3. Discharge (cfs) versus frequency.

*4. Discharge (cfs) versus flood stage.

5. Flood stage versus area flooded.

The economic appraisal involves establishing and relating monetary values to the physical flood characteristics and to frequency of flood occurrences. These associations, generally expressed by means of graphs, include the following, which are developed as needed to evaluate different types of floodwater damages.

1. Area flooded versus damage.

*2. Flood stage versus damage.

3. Discharge versus damage.

*4. Damage versus frequency of occurrence.

*Samples of these graphs are illustrated in Figures 3.1 through 3.4. Such graphs make possible the computation of average annual flood damages for the stream reach covered by the graph.

1. Stage-Damage

Flood damage surveys provide the basis for formulating this curve (Figure 3.1). The height of an experienced flood is used as the base point from which stages of other experienced or potential floods are referenced. Damages are appraised for sufficient stages to define the shape of the curve adequately. Columns 1 and 2, table 3.1, illustrate this phase of the frequency method.

2. Stage-discharge and discharge-frequency

Details of the construction of stage-discharge and discharge-frequency graphs are given in Chapters 14 and 18, respectively, of the Hydrology Handbook - for watershed planning.

Figures 3.2 and 3.3 and columns 3 and 4 of Table 3.1 indicate application of these data in the procedure.

The damage-frequency curve, figure 3.4, is drawn through the plotted values of corresponding damage and frequency. The values used in producing this graph are shown in Table 3.1. Average annual damage is determined from the damage frequency curve by the following calculations:

a. Planimeter in square inches the area enclosed by the curve.

b. Determine the product of the values of the abscissa and the ordinate at the point one inch from the point of origin. This value determined from figure 3.4 is obtained as follows: abscissa one percent, ordinate $100,000, giving a product of $1,000.

c. Product of the total square inches measured in a. (13.39) and unit value per square inch determined in b. ($1,000) is equal to average annual damage ($13,390).

Table 3.1 - Reach No. 4 _____ Creek
Damages Resulting from Floods of Different Sizes and Frequencies

Flood stage in relation to flood of 6/15/45 (Feet)	Damage (Dollars)	Peak Discharge (c.f.s.)	Chance of Occurrence 1/ (Percent)
+ 2	1,000,000	4,200	Less than 1
+ 1	720,000	3,450	Less than 1
6/15/45	410,000	2,800	1.4
- 1	110,000	2,000	3.2
- 2	10,000	1,500	6.0
- 3	0	1,200	7.5

1/ Frequency of occurrence may be expressed in several ways, each of which may be converted to the other. The term used herein should be interpreted to mean the percent chance of a given peak discharge being equalled or exceeded in any one year.

The frequency series offers an approach to computing average annual damages by weighting the effect of all floods without estimating losses separately for each flood in a long series of events, thereby providing an estimate at a saving of work over the historical series method. Thus, when conditions are suitable for its use, such as when damageable values can be restored between floods as in residential areas, it is the preferable method.

The seasonal distribution of floods must be taken into account when evaluating crop and pasture damages. This is necessary because of the difference in flood damage resulting from given flood stages during different periods of plant growth. The relative frequency of flooding by seasons or months furnishes the basis for making the adjustment. (Methods for making this determination of seasonal frequency are described in Chapter 18, Hydrology Handbook - for Watershed Planning).

Upon the determination of the seasonal distribution of flooding, a composite acre value for each stage is developed and the damage is calculated for each time period, usually by months of the growing season. The composite acre damage for each time period is then weighted by applying the percent likelihood that a damaging flood will occur. The weighted damage by time periods is then totaled to determine the annual composite monetary damage (See Table 3.2). This calculationn makes possible damage estimates by flood stages leading to the development of a stage-damage curve for the reach.

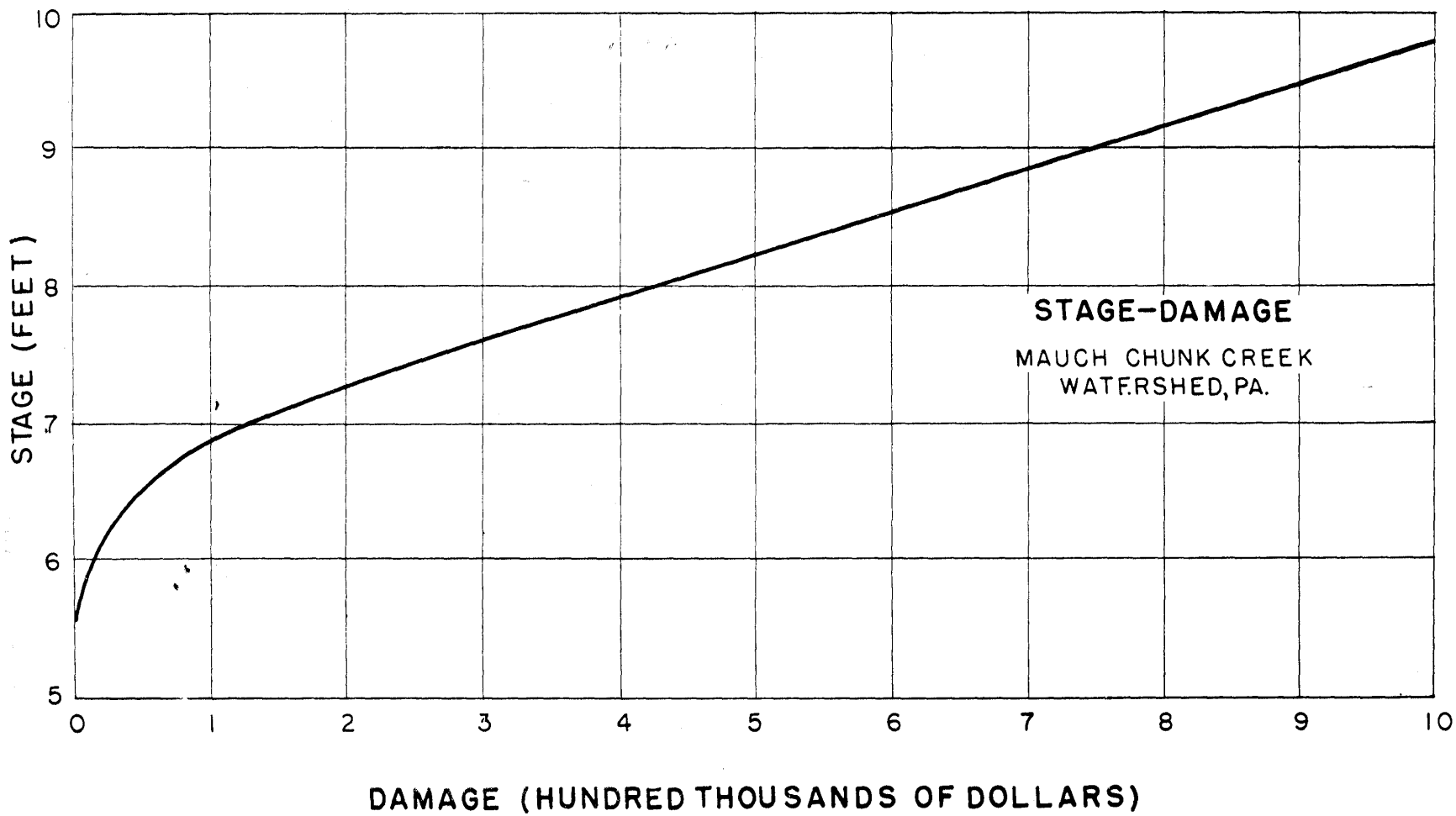

STAGE-DAMAGE
MAUCH CHUNK CREEK
WATERSHED, PA.
STAGE (FEET)
10
9
8
7
6
5
0
1
2
3
4
5
6
7
8
9
10
DAMAGE (HUNDRED THOUSANDS OF DOLLARS)

Figure 3.1

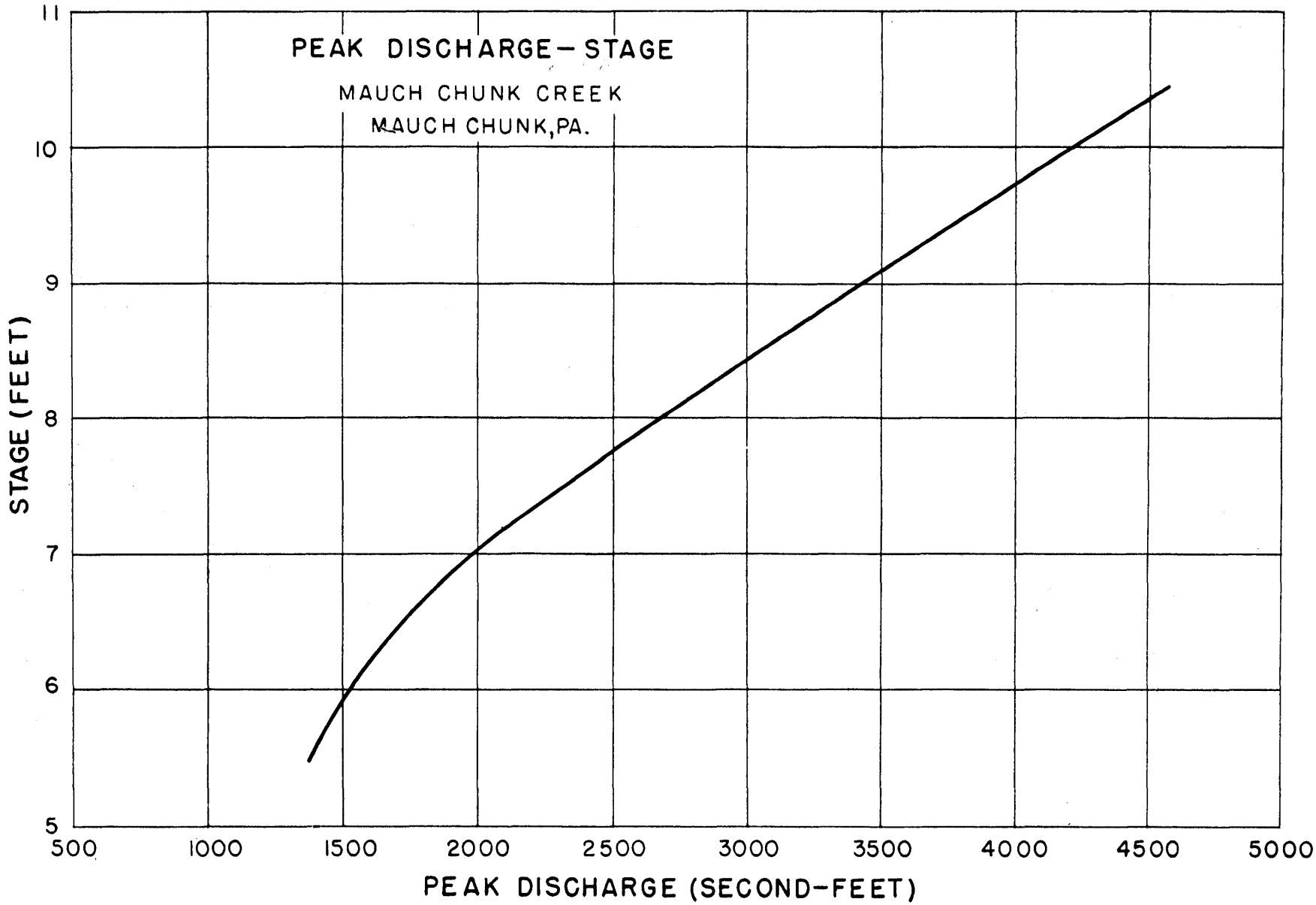

PEAK DISCHARGE-STAGE
MAUCH CHUNK CREEK
MAUCH CHUNK, PA.
STAGE (FEET)
11
10
9
8
7
6
5
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
PEAK DISCHARGE (SECOND-FEET)

Figure 3.2

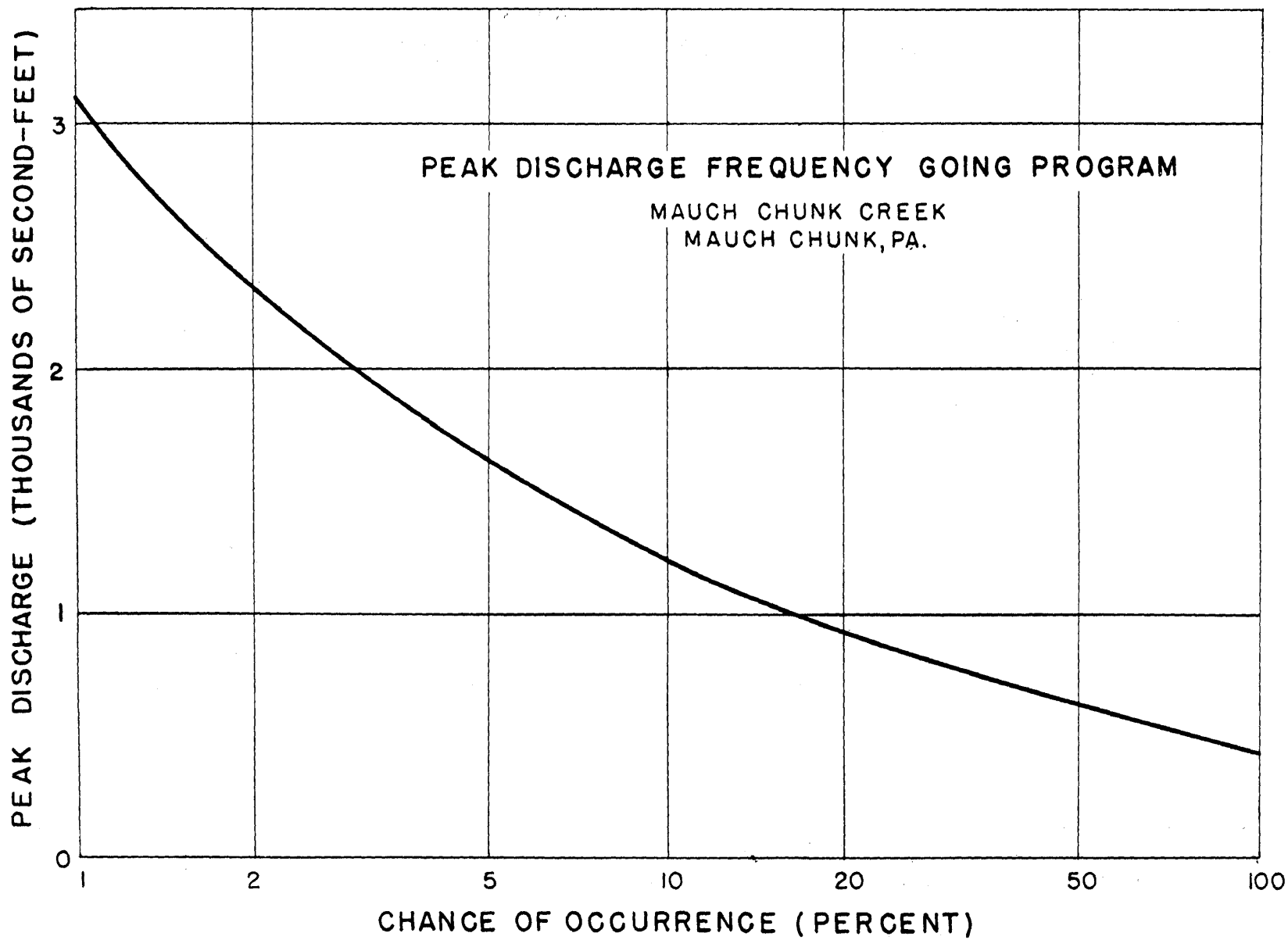

PEAK DISCHARGE FREQUENCY GOING PROGRAM
MAUCH CHUNK CREEK
MAUCH CHUNK, PA.
PEAK DISCHARGE (THOUSANDS OF SECOND-FEET)
0
1
2
3
1
2
5
10
20
50
100
CHANCE OF OCCURRENCE (PERCENT)

Figure 3.3

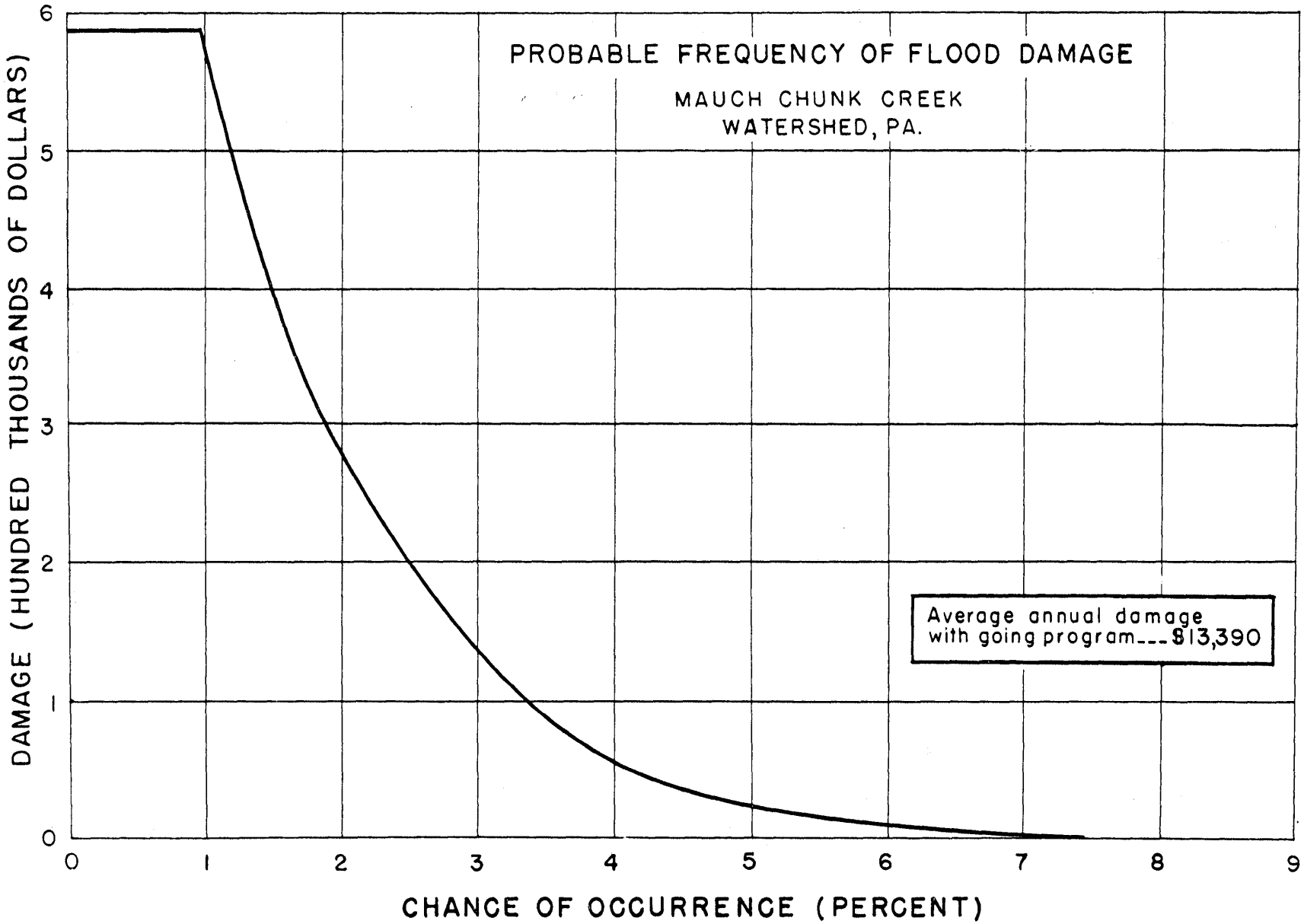

PROBABLE FREQUENCY OF FLOOD DAMAGE
MAUCH CHUNK CREEK
WATERSHED, PA.
Average annual damage
with going program---$13,390
DAMAGE (HUNDRED THOUSANDS OF DOLLARS)
0
1
2
3
4
5
6
CHANCE OF OCCURRENCE (PERCENT)
0
1
2
3
4
5
6
7
8
9

Figure 3.4

TABLE 3.2

Frequency Method

Sample Calculation of Cropland and Pasture Stage-Damage Relationship at 2' Stage for Reach I

Time Period	Damage at 2' Stage per Composite Acre ($)	Percent Chance of Flood Occurrence in any 1 Year	Weighted Per Acre Damages ($)
January	0	5	0
February	0	5	0
March	.48	15	.07
April	1.35	15	.20
May	6.85	5	.34
June	20.00	5	1.00
July	56.00	5	2.80
August	61.00	5	3.05
September	32.00	10	3.20
October	15.00	15	2.25
November	1.80	8	.14
December	0	7	0
TOTAL	xxx	100	13.05

Number of acres in reach at 2' stage = 85 acres.

85 acres x $13.05 damage per composite acre = $1,109.25 crop and pasture damage in Reach I at 2' stage. (Although the value calculates to $1,109.25, it is suggested that it be rounded. In this case for plotting purposes $1,100 probably would be the limit of accuracy.)

When crops are flooded more frequently than once a year, the damaging effect of the succeeding flood is altered by the effects of the previous flood. Two 100 percent chance events occurring during a given crop year will produce less total damage than if they were to occur in successive years, although the probability of either sequence is about the same. Therefore, it is necessary to adjust the crop damage estimates to account for recurrence of flooding. It is essential that the method of adjustment take into account the fact that if the project is effective a greater adjustment will be needed for non-project than for project conditions. The project can be expected to eliminate some recurrent flooding.

B. Historical Series Method

In using the historical series method, an evaluation period is selected where the cumulative annual departures from normal precipitation are minimized. Essentially this method rests upon the assumption that a sequence of events that has occurred in the past also may occur in the future. Floods of extreme magnitude (usually those with an expected recurrence interval of twice the evaluation period, or longer) should be excluded from the series unless appropriate adjustments are made.

After each of the various categories of damage have been appraised for each flood during the evaluation period under future conditions without the project, they should be summed and divided by the number of years in the period. The answer is the unadjusted average annual damage. The figure is then adjusted for recurrent flooding, or otherwise as needed, to obtain the average annual damage.

Caution should be observed with regard to the evaluation period. It often happens that the period of record of stream gages or rain gages involves fractional parts of a year. Evaluation periods should comprise complete years, dropping all fractional periods from consideration. Unless floods occur annually, an error may be introduced by starting and ending the evaluation period with floods. For example, flood damages may be estimated for a period of 20 years (1937 - 1956 inclusive) during which time 7 floods occurred. An examination of the record (or other reliable sources) shows that the last flood previous to 1937 occurred in 1934. Hence the flood period covers more than 20 years.

The flood series should be adjusted by dropping from consideration small floods that occur in such close proximity to larger ones that restoration of damageable values would not be possible.

Stage-damage curves are developed when the historical series method is used. As the dates and sequence of flooding are available, separate curves usually are developed by months or seasons. When depth of flooding is the chief determinant of the rate of crop damage from a given flood, the hydrologist may develop curves which relate the

acreages flooded within different depth zones to flood heights. A sample of a set of curves of this type is shown in figure 3.5. It is assumed for illustration that during the spring season, the crop damage along this reach for different depths of flooding are:

0 - 1 foot - $3.00

1.1 - 3 feet - 5.00

Over 3 feet - 7.00

The acres flooded at different depths by flood stage from figure 3.5 multiplied by these damage rates will provide the basis for development of figure 3.6.

Then figure 3.6 illustrates the appropriate stage-damage curve for crop damage in this reach from spring floods.

It is possible in the historical method to develop a single stage-damage curve for the entire year by weighting the damage factors by the seasonal occurrence of flooding. However, this procedure results in little, if any, saving in time.

When using the historical series it generally is found that several floods occur during a single year. In other years there may be no flooding. In such cases it is incorrect to add the unadjusted damage to crops and pasture for each flood in the evaluation series and use the sum as the total damage. The first flooding during the year will reduce the value of the crops somewhat so the second flood will find less value to damage. Some portion of the value sometimes may be restored between floods through replanting or otherwise but the yield of the late crop usually will be reduced. One method of calculating these changes in value, and in resulting damage, is by making a flood-by-flood analysis. These calculations are laborious when an evaluation series includes a considerable list of floods.

Calculations of this type have been used to develop empirical short-cut formulas to adjust damages for recurrent flooding. One such formula used in several states is represented by the equation $1/Y = 0.7706 + 0.2387X$. Here X is the sum of the areas flooded by all floods in the series divided by the sum of the areas flooded by the largest flood each year. Y is the percentage of the damage, as calculated from the individual flood events, to be used in correcting for recurring floods. This equation does not provide for restoration of value between floods.

An example of the correction under this equation follows: The total acreage flooded by all floods in a 20-year period was 200,000 acres. There was no flood one year and the sum of the acreages flooded by the largest flood each year was 80,000 acres. X therefore equals 200,000/80,000 or 2.5. The average annual damage found by considering

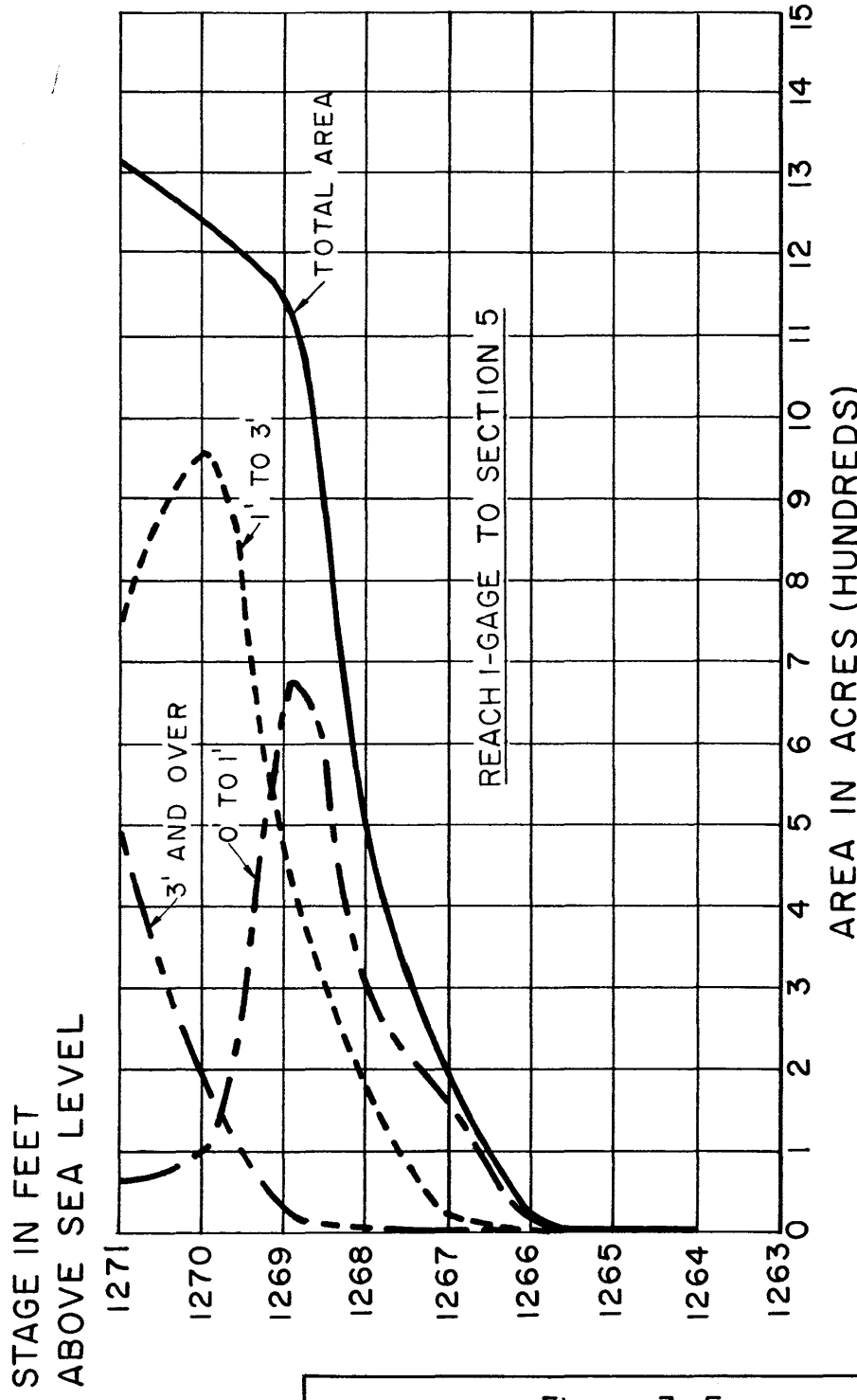


Figure 3.5
INUNDATED AREA CURVES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

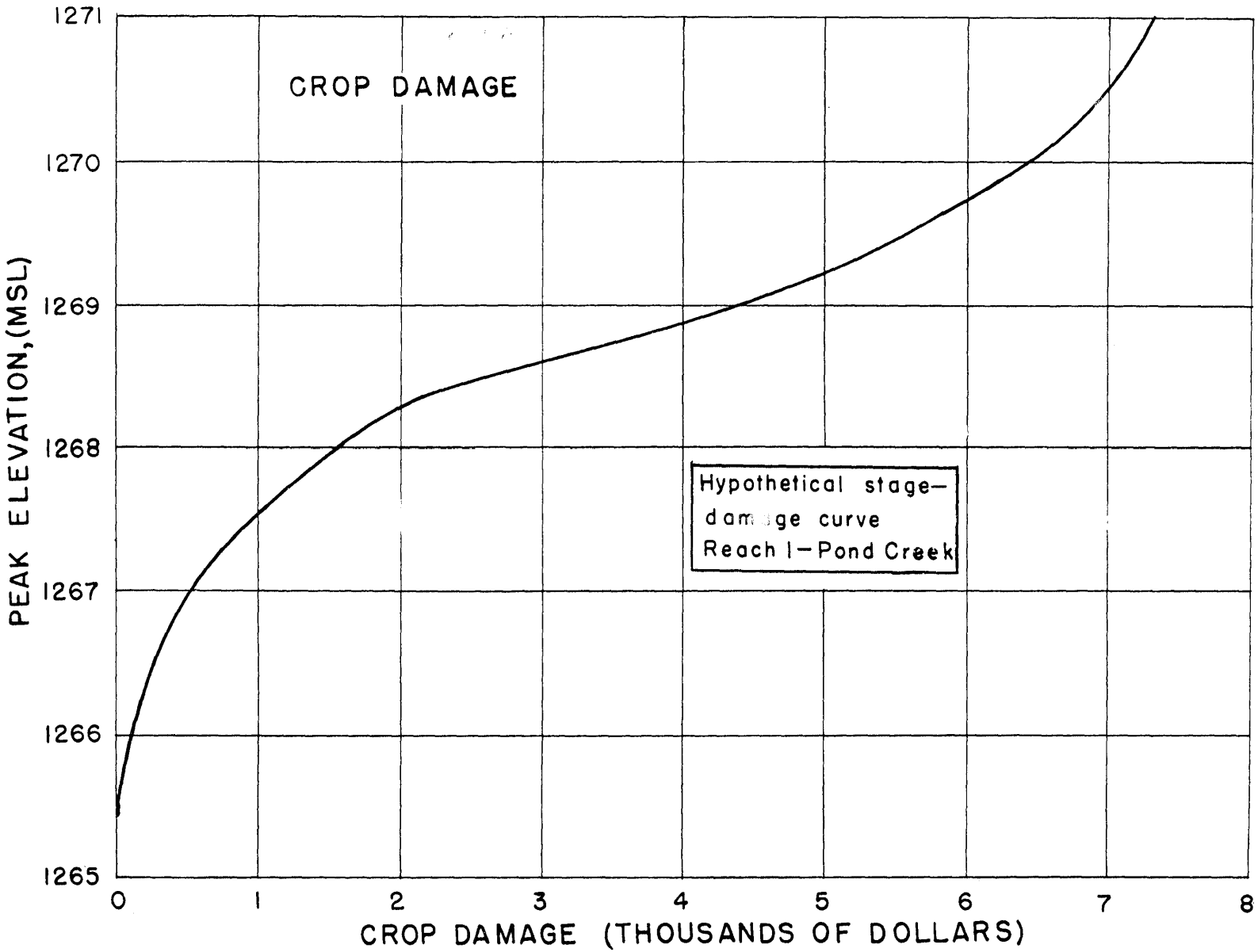

CROP DAMAGE
Hypothetical stage–damage curve
Reach I–Pond Creek
PEAK ELEVATION, (MSL)
1271
1270
1269
1268
1267
1266
1265
0
1
2
3
4
5
6
7
8
CROP DAMAGE (THOUSANDS OF DOLLARS)

Figure 3.6

each flood separately was $50,000. Substituting in the formula, $1/Y = 0.7706 + 0.2387\ (2.5) = 0.7706 + 0.5968 = 1.3674$. Then $Y = 0.7313$ and the adjusted average annual damage would be $50,000 x 0.7313 or $36,565.

The approach gives less correction for recurrence under project conditions than for conditions without project. Such a result is in accord with experience. The project is likely to eliminate a number of small floods but it probably will have less effect on the large ones. Hence there is less recurrent flooding.

In the states where it is used, the equation has been tested repeatedly and found to give results which seldom differ by more than two percent from those obtained through a flood-by-flood approach. Presumably in other areas of the country where growing seasons and crops are different, a somewhat different equation should be derived.

The historical series method requires somewhat more work for the hydrologist and economist than does the frequency method. However, when flooding is frequent and the major damage is to crops and pasture it allows a positive approach to the adjustment of damages from recurrent flooding.

C. Overland Flow

In some watersheds tributary ephemeral streams may discharge their floodwater onto alluvial areas with no defined channel to the main watercourse. Usually these alluvial areas are flat or only gently sloping in both directions and the floodwater spreads out until the flow eventually is dissipated. This situation wherein there is virtually no channel or where the possibility of lateral spreading is great is called overland flooding.

Under natural conditions, these alluvial areas were natural spreading areas for runoff. Because of favorable topographic and soil characteristics many have been developed into highly productive farming areas and in some cases into urban and suburban areas. The increased value of property and its greater susceptibility to damage, together with the inability of individuals to protect their property because of the unpredictable path of the flood flows, has created serious local flood problems.

Peak discharge and flood stage have little meaning in overland floods. When the floodwater emerges from the confined section onto the alluvial fan or plain the flood peak quickly flattens. As a result, the area flooded is not a direct function of the peak discharge except as it may overtop diversion dikes built to direct its course away from a portion of the flood plain. More often, the area flooded is directly related to the flood volume. The greater the volume, the greater is the area flooded.

The relationship is illustrated in the White Tanks Watershed in Arizona. Floodwater from this watershed debouches from the White Tanks Mountains onto a highly productive gently sloping flood plain. Once the floodwater breaks through the highline irrigation canal, it spreads out over the farm land in relatively shallow sheet flows except where it is concentrated or obstructed by railroad and road fills, ditches or other man-made obstacles. It seldom reaches the Agua Fria or Gila Rivers. The relationship between flood volume and acreage flooded is shown in the following tabulation:

Flood Date	Volume Acre-Feet	Acres Crop Land Flooded	Acres Flooded Per Acre-Foot
August 1939	3,500	4,600	1.3
September 1956	7,000	7,500	1.1
September 1949	2,500	3,000	1.2
January 1951	5,500	7,000	1.3
July-August 1951	11,500	14,100	1.2
Total	30,000	36,200	1.2

A large area of cropland in this watershed lies in the flood plain. Not all would be subject to flooding by a single flood, but most is subject to the flood hazard by slight changes in the paths of flood flows. Even the 100-year flood would inundate only about 25 percent of the flood damage area.

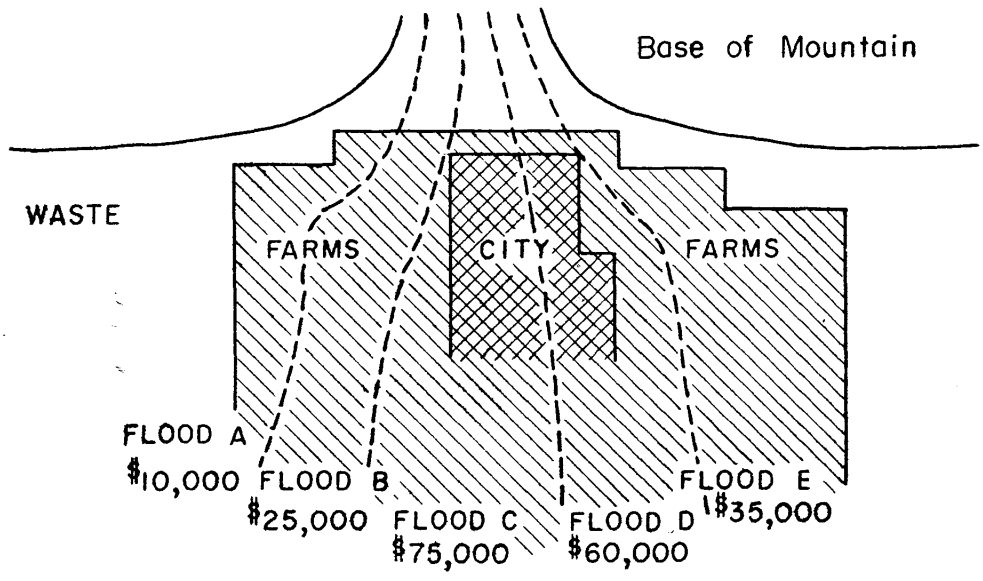
In overland flow situations with relatively little ponding, farm damage per acre flooded appears to be relatively constant irrespective of the size of the flood. This is illustrated again in the following tabulation for the White Tanks Watershed for two floods, both of which occurred in August.

Type of Damage	1939 Flood	1951 Flood
Crop	$28.75	$28.60
Land	8.89	10.14
Farm ditches	3.91	3.60
Miscellaneous farm damage	1.69	3.11
Total farm damage/acre flooded	$43.24	$45.45

Since the 1951 flood was over three times as large as the 1939 flood, it was concluded that flood damage was proportional to the acreage flooded, which in turn was proportional to the flood volume. Hence, it was necessary only for the hydrologist to determine a flood volume-frequency series to provide a basis for determining average annual flood damages over a normal hydrologic period.

Overland floods seldom follow the same path. During the interval between floods, even minor changes in the flood plain such as small dikes, road and railroad fills, irrigation ditches or even land leveling have been known to alter the course of flood flows. Sediment deposition where there is an abrupt change of grade is also an important factor in altering their course. This unpredictability is not particularly important where there is homogeneity in the flood plain. However, many alluvial fans or other alluvial areas exhibit a wide variety of damage potential due to differences in kind and extent of development. If a flood strikes the developed area of the flood plain serious damage may result, whereas if it followed a path through the undeveloped area little or no damage would occur. Hence, it is necessary in such situations to determine the mean damage resulting from a flood of certain size, taking into consideration the probability of the flood following any one of several possible paths.

This problem is illustrated in the following sketch:



Through the use of topographic surveys, aerial photographs, and maps of historical flood flows, flood paths A, B, C, D and E are traced through the flood plain. Flood damages are determined from known relationships between damages, flood depths, and velocity. If a flood of the magnitude being studied has an equal chance of following each of the flood paths then the probable damage from such a flood is equal to the mean value of the five alternatives which in this example is $41,000. Similar studies made for floods of different magnitudes would furnish the basis for damage-discharge curves.

In the arid regions where the overland flow technique has been used most frequently, there are only a few floods in a 20-year period. The few gage records that exist indicate that even when floods are so infrequent, there are generally two or three years during which more than one flood occurred. However, recurrent flooding during a single year over the same area is unlikely because of the alternative paths the flow can take.

Either the historical series or the frequency method may be used in the overland flow analysis. The distinction between overland flow and the usual methods of analysis is that here the hydrologist determines the total flood volume instead of flood routing to establish peak flows.

D. Net Income

A method which theoretically is sound, but which is likely to have practical difficultues, is the evaluation of flood damage and the benefit from its reduction through the change in net income after project installation. This procedure is applicable where nearly all damage is to crops and pasture and the control of flooding after project installation will be almost complete. It also is used in most cases where inseparable flood prevention and agricultural water management benefits are being evaluated.

The procedure consists of determining the land use, average crop yields and net return without project and comparing these with flood-free yields, the degree of restoration to former land use, and the net return under project conditions. The difference in the net return constitutes the flood damage. The increase in the net return over non-project conditions as a result of project installation constitutes the project benefit through reduction of damage. Additional benefits may accrue through increasing the intensity of land use beyond that which has been attained in the past. In most cases, as in combined flood prevention and drainage, there is no need to separate the benefits from restoration from those resulting from land use change or intensification.

A major difficulty is to determine how closely the average crop yield after project approaches the flood-free yield when protection is incomplete. Another problem is the determination of additional production costs under these circumstances.

Nevertheless, this procedure can shorten greatly the work required for damage appraisal. The effect of recurrent flooding is considered automatically in determining the yields and land use under non-project conditions.

III. STEPS IN DAMAGE APPRAISAL

The following outline of steps necessary to appraise floodwater damages adequately is applicable to many varied situations. Unusual conditions may require some adaptations. Understanding of the principles involved will provide a basis for making the adaptations necessary to cope with unusual problems.

A. Selection of Areas for Study

To obtain statistically reliable data in watersheds covering only a few square miles, it may be necessary to obtain information on the entire flood plain. However, a sampling procedure should be employed where practical. On larger watersheds a sampling procedure usually should be employed in all cases.

The first step in selection of a sample for detailed investigation is a careful reconnaissance of the whole area to be studied so that all major problems or conditions will be sampled. Stereoscopic analysis of flood plain photographs will be useful.

The selection and use of appropriate stream and flood plain reaches provide a means for (1) identifying the location of damages and benefits; (2) bringing the evaluation of hydrologic and economic data together for determination of stage-area-damage relationships; and, (3) relating damage reductions or other benefits to works of improvement.

In setting up the sample of areas for detailed investigation, attention to these points is important:

1. Important variations in flood plain characteristics and in land use should be considered. (An example of this would be where a flood plain crosses two or more problem areas or if an urban area is involved.)

2. Both sides of the stream should be represented.

3. Differences in channel size and valley width from the headwaters to the bottom reaches should not be overlooked.

4. Portions of the flood plain should not be excluded from the possibility of being drawn in the sample for any reason.

5. The selection should facilitate separate evaluation of individual structures or groups of structures.

B. Collection of Basic Data

1. Maps

Major land use in the flood plain may be mapped on aerial photos, overlays, or sketches, depending upon the need. The map should show improvements such as roads, buildings and bridges subject to damage. Where urban and residential areas are subject to flooding it is desirable to use a detailed map. Many towns and cities have maps that will help fill this need. Land use capability classes and soil delineations also may be shown on the flood plain map. It usually is not necessary to show crop distribution throughout the flood plain, however, it will be desirable to show crop distribution in a few representative sample valley sections. Locations of areas significantly affected by flood plain scour, deposition and streambank erosion may be delineated on the map to complement the investigations of the geologist.

2. Cost and Price Data

Production cost data usually are available from State Colleges of Agriculture. Local agricultural workers can assist in providing information on the farming operations common to the area. Most of the Engineering and Watershed Planning Units have developed costs of producing various crops applicable to fairly wide areas such as a Land Resource Area. If a given operation, such as combining, usually is done on a custom basis in a community, the custom price may be considered as a cost of operation.

When using cost data from the various sources, care should be taken to check its applicability to watershed planning. The following are among the points to consider. The price base should be known so that prices can be converted to projected levels. The economist should find out exactly what items of cost his data include. Among these are interest and depreciation of equipment, labor whether hired or unpaid family, and cost of obtaining and applying fertilizer and insecticides.

3. Collection of Field Information

Information regarding damages experienced may be obtained from the operators of flood plain land. It is recommended that this information be recorded on a flood damage schedule rather than loose notes to make sure that comparable information is obtained from all respondents. Figure 3.7 is a sample schedule illustrating the general type of data needed.

This information will furnish basic data for estimating damageable values and rates of damage for all classes of agricultural property or will provide the basis for making adjustments to standard damage data already developed.

Flood Damage Schedule Work Sheet
(Sample)

Name _____ Years on Farm _____ Subwatershed _____

Flood of _____ Acres Flooded _____ How frequently do floods of this size occur _____

Acres Flooded by Largest Flood _____

NOTES

Damage to Crops and Pasture From Flood of Above Date

Crop	Depth	Acres Flooded	Present Acres This Crop	Expected Yield If No Flood	Yield After Flood	Extra Cost Kind	Extra Cost Amount	Expenses Saved Kind	Expenses Saved Amount
Cotton	0'-2'	10	5	200 lb.	150	Replant Extra	10	Picking	50 lbs/ac
Corn	0'-2'	10	5	30 bu.	15	Cultivation	10	Harvest	15 bu/ac
Wheat	2.1'-4'	10	10	15 bu.	10	Combines	10% longer to harvest	None	
Johnsongrass Meadow	2.1'-4'	5	15	1 ton	1	None	-	None	
Pasture	4.1'-6'	10	10		No damage				

Other Damage From this Flood

Type	Damage
_____	Quantity _____ Value
Fence	4 rods
Poultry	12 hens
Livestock	1 heifer

Equipment None

Levees None

*Scour 5A/20%

*Bank Cutting _____

*Sediment 5A/25%

Value of Cropland: $100 acre

Value of Pasture: $30 acre

Q. What changes in land use have been made due to floods? A. 10 acres of row crops to Johnsongrass meadow.

Q. What changes would be made if the frequency of flooding were reduced by half? A. All of meadow to crops and 5 acres of pasture to crops.

Q. How often do large floods occur? (If the flood described above is a large flood, change this question to small floods.) A. Once in 8 years.

Q. During what seasons are floods most common? A. Large floods: Spring - 1/2; Fall - 1/2. Small floods: Spring - 3/4; Fall - 1/4;

Q. In addition to the loss in yield described above, was there any damage to quality of crops? A. Wheat-weeds because wheat down. (Estimated percent. Docked price of wheat 25%.

Q. What damage did this flood do to roads and bridges nearby? A. Washed out approaches, about 10 loads needed.

*These items may be total damage since he has been on the farm.

Figure 3.7

Many farmers can give information about only one flood. This may be the most recent, the largest, or the most damaging he has experienced. However, information should be obtained on as many floods as possible. The enumerator should obtain as accurately as possible the proportion of cropland in the various crops. Although normal crop rotations will cause different crops to occupy a given field from year to year, the over-all distribution should reflect the situation in the flood plain. It can be expected that some cropland will be idle. The division of the flood plain among cropland, pasture, woodland and other uses in some cases can be determined by planimetering recent aerial photos of the flood plain.

The data thus obtained usually represents present land use and cropping patterns. Adjustments should be made where these data do not represent the expected future land use and cropping pattern without project. Evaluation of conditions as they may be affected by the project is described in Chapter 4.

Most of the information collected through farmer interviews should be in terms of physical quantities rather than values. Their monetary evaluation should be made in the office. Otherwise, much time will be used in trying to determine what items the farmer has included in his value estimate and the price base he has used.

Information on damages to non-agricultural property also may be obtained and recorded on appropriate flood damage schedules. Special schedules may be needed to record damages to residential, commercial, and industrial property as well as to highways, bridges, railroads and utilities. Figure 3.8 shows a sample schedule for residential flooding. If there are numerous residences subject to damage, a sampling procedure may be used. When there are considerable differences in the types or values of the affected residences, the sample should be stratified to reflect these differences. Commercial and industrial establishments are so varied in their equipment, inventory, and susceptibility to damage that a complete inventory is advisable in most small watersheds. Except for residential damage, most non-agricultural damage data will require less editing in the office than is needed for agricultural damage. Reasonably accurate records generally are used in industrial or commercial enterprises.

C. Analysis of Damage

Damage estimates are based upon information obtained in the field. This information constitutes the raw data which must be analyzed and processed before it can be correlated with data worked out by other specialists to obtain an accurate appraisal of the effects of the project.

The planning party is faced at all times with the problem of balancing scanty data with the cost and the time required to obtain and

FLOOD DAMAGE - RESIDENTIAL
(Sample)

Watershed _____ Reach _____

Location of property: Stream mile _____ No. _____

Occupant _____ Years Occupancy _____

Damaging floods: No. _____ Dates _____

APPRAISAL OF DAMAGE

Property damaged	Experienced or Potential Floods 1/		
	Extent of damage		
Residence and contents			
(Depth of water in basement)			
(Depth of water on first floor)			
Foundation			
Basement and contents			
Floors and walls			
Furniture			
Personal belongings			
Lawn			
Garage (depth of water)			
Other buildings (depth of water)			
Automobiles (depth of water)			
Other losses			
Clean-up			

Relevant Data:
Type of residence: Frame _____ Masonry _____. Size of residence _____ square feet. Market value of residence $_____. Replacement value of furniture $_____. For experienced flood describe any emergency activity for prevention of losses or evacuation _____

1/ Indicate the date of experienced floods. Show height of other flood stages in terms of plus or minus depth increments referenced to the experienced flood.

Figure 3.8

analyze more complete information. It may be necessary to adopt certain assumptions and to develop short-cut procedures in order to obtain reasonably accurate answers with minimum planning costs. In so doing, it is important to remember that assumptions are not necessarily facts.

1. Crop and Pasture Damage

The floodwater damage that will be sustained by crops and pasture depends upon the damageable value of the crop, the seasonal occurrence and frequency of flooding, and the characteristics of the flooding such as depth, velocity of flow, sediment load and duration. The damage schedules can form the basis for estimating many of these factors.

The yield which would have been obtained in a watershed had there been no flooding is a hypothetical figure. Flood plains of creek watersheds are so small that accurate yield data from secondary sources seldom are available. Basic data on the yields to be expected in the flood plain can be obtained from the schedules, but these should be scrutinized rather carefully.

The data obtained from the schedules may be biased as many other things might have happened to reduce the yield had a flood not damaged or destroyed the crop. The reported yields should be adjusted in the light of knowledge of fertility, farming methods, etc., in the area. Excellent data on crop distribution and yields often may be obtained from ASCS offices. The degree of damage from scour and overbank deposition of sediment reported by the sedimentation party also should be considered.

The flood-free yield so determined may be adjusted further by consideration of the effect that improved technologies may have during the project life. Some agricultural colleges and experiment stations have developed estimates of the yield increases that can be expected from this source at various benchmark dates. Other estimates have been made as a part of river basin studies. An assumption often used is that the best practices now in use will be common within 15 or 20 years. Benchmark yield data from Work Unit Technical Guides may be useful. In estimating future flood-free yields without the project, consideration should be given to the degree to which the risk of flooding will inhibit the full use of improved techniques.

Percent damage factors are derived for each crop to relate the damage to the month or season and the depth or duration of flooding. An example of steps required in the estimation of the percent damage to a given crop at each depth increment of flooding during a given month or season is shown in table 3.3. Similar procedures can be used for other depths or duration of flooding and for other seasons or months. This procedure should be repeated for each of the crops in the flood plain.

The schedules that can be obtained in most watersheds will not furnish adequate information for determination of the percent damage factors for all months or seasons and perhaps for all depths or durations, because information usually can be obtained in a creek watershed on only a few floods. Damage information that previously has been obtained in similar areas may be used to supplement field data on a given watershed to indicate general relationships and to fill in gaps where the field data are inadequate. It is desirable, however, to calculate some basic percent damage factors for each watershed because of differences among watersheds in velocity of flow, soil detachability, topography or sediment load.

The major land use may be determined from the flood plain map. The present crop distribution in the flood plain can be obtained by adding the figures shown in the present acreage column from the schedules. Usually it is desirable to adopt the land use acreage at the year planning is begun to represent present conditions. If there are obvious reasons for making adjustments to reflect normal conditions more nearly, the acreages should be adjusted. A final adjustment will be the conversion of the existing use to that which can be expected in the future without project.

In some cases a uniform land use can be assumed in the flood plain. On other watersheds inspection of the flood plain may show a considerable difference in land use between upper and lower reaches of the stream. If this is the case, different land uses and damageable values should be used for the two (or more) reaches. Sometimes there may be significant variations in a given cross section in land use with elevation above the bankfull stage. The acreage inundated first may be woods or idle land in which there is little or no damage. If this is the case, it should be separated from the acreage damaged by flooding.

Table 3.4 shows a method of calculating the composite damageable value per acre of flood plain, when uniform land use is assumed.

The damageable value of each crop, determined as shown in table 3.4 can be multiplied by its percent damage factor and the products added to give the damage from flooding an average acre of flood plain to a given depth during each season. Table 3.4 illustrates a procedure.

The damage rates are multiplied by the acreages inundated for representative stages to develop crop damage curves, similar to that shown in figure 3.6. Development of damage curves for seasons rather than one for each month is adequate in most cases. This will substitute the development and reading of three or four curves for the twelve otherwise required.

Table 3.3 Flood Damage to Cotton, 3' and Over, Spring Flood, Village Creek.
(Sample)

Schedule No.	Acres Flooded	If No Flood: Estimated Yield	If No Flood: Total Production	If No Flood: Price Per Unit	If No Flood: Total Value	After Flooding: Actual Yield	After Flooding: Total Production	After Flooding: Price Per Unit	After Flooding: Total Value	Gross Damage	Expenses Saved	Net Value Alternate Crop	Added Expenses	Net Damage
	(1)	(2) (lbs)	(3) (lbs)	(4) $	(5) $	(6) (lbs)	(7) (lbs)	(8) $	(9) $	(10) $	(11) $	(12) $	(13) $	(14) $
72	40	300	12,000	0.386	4,632	0	0	0	0	4,632	1,782	916	0	1,934
121	10	135	1,350	0.386	521	0	0	0	0	521	162	0	0	359
114	8	250	2,000	0.386	772	133	1,064	0.386	411	361	112	0	10	259
Total	58	228(av)	15,350		5,925		1,064		411	5,514	2,056	916	10	2,552

Damage Per Acre Flooded $44.00

Percent damage 43

Procedure: Column (1) x Column (2) = Column (3). Column (3) x Column (4) = Column (5).
Column (1) x Column (6) = Column (7). Column (7) x Column (8) = Column (9).
Column (10) = Column (5) minus Column (9).
Column (14) = Column (10) plus Column (13) minus the sum of Columns (11) and (12).

Table 3.4- Composite Damageable Value Per Acre of Flood Plain
(Sample)

Crop Use	Percent in This Use	Unit	Yield Per Acre of Crop	Production Per Flood Plain Acre	Value Per Unit (Dollars)	Damageable Value (Dollars)
Corn	6.3	bu.	30	1.89	1.24	2.34
Cotton	6.3	lb.	183	11.5	0.386	4.44
Oats	10.5	bu.	33	3.46	0.81	2.80
Wheat	6.6	bu.	18	1.19	2.00	2.38
Hay, (J.G.)	0.3	tons	2.0	0.006	16.22	0.10
Pasture	67.0	A.U.M.	2.50	1.68	2.61	4.38
Misc.	3.0					

Table 3.5- Composite Crop and Pasture Damage Rate, per Acre Flooded, by Depth of Flooding, Spring Season (April, May and June)
(Sample)

Crop	Damageable Value Per Acre (Dollars)	Net Damage: Depth 0 - 1.0' (Percent)	Net Damage: Depth 0 - 1.0' (Dollars)	Net Damage: Depth 1.1' - 3.0' (Percent)	Net Damage: Depth 1.1' - 3.0' (Dollars)	Net Damage: Depth 3.1' and Over (Percent)	Net Damage: Depth 3.1' and Over (Dollars)
Corn	2.34	26	0.61	35	0.82	47	1.10
Cotton	4.44	17	0.75	41	1.82	52	2.31
Oats	2.80	32	0.90	50	1.40	63	1.74
Wheat	2.38	33	0.76	50	1.19	63	1.48
Hay, (P.G.)	0.10	20	0.02	23	0.02	36	0.04
Pasture	4.38	10	0.44	18	0.79	20	0.88
Total			3.48		6.04		7.55

The above illustrates a procedure for watersheds where depth of inundation is more meaningful than duration of flooding. This is the situation on most watersheds. However, when water gathers on a wide, relatively flat flood plain it may remain for a considerable time. If this occurs duration may be the most important factor. Increments of duration may be handled in a manner similar to that illustrated for depth increments.

2. Other Agricultural Damage

The damage schedule should contain spaces for recording such other agricultural damage as livestock losses, damages to fences, farm equipment, farm levees, etc. It is suggested that the physical amount of such damage be recorded and monetary values be determined in the office. One reason is that if a farmer reports $100 damage to his fences from a flood in 1958, he may be thinking of what it cost him then, or he may have in mind what it would cost at today's prices. A second reason is that when a farmer gives damage in monetary terms, one needs to have a definite understanding of whether he means only out-of-pocket cash costs or such costs plus the value of unpaid family labor or a complete cost including interest and depreciation on farm equipment. Such monetary values are more difficult to pin down where fences, livestock, etc. are involved than if only crop values are concerned.

Seasonal curves for these other agricultural damages ordinarily will not be needed. Damages of this type may not start until a fair stage overbank is reached. As an example, floodwater probably will need to be at least two feet deep before there is much damage to fences. On the other hand, damage from infestation by noxious weeds may begin at a low flood stage. The sampling procedure used for estimation of crop and pasture damage will be applicable to estimates of damage of this type. Expansion of data from the sampled areas to the entire flood plain can be made safely if the sampling has been done correctly.

When irrigation, drainage, or farm levee systems exist in a watershed and are subject to flood damage, they should be given special consideration and evaluated separately. For example, the damage to an irrigation system might consist only of silting up the ditch or washing out a siphon but before repair of such damage could be made the inability to use the system might cause loss of a crop because of lack of water.

3. Nonagricultural Damage

Most of the damage in small watersheds may be to agricultural property, with a certain amount of damage to such transportation facilities as roads, bridges and railroads. In some areas, however, there will be damage to residential, commercial, and industrial property and to parks, schools and the like. Appraisal of these damages often will require special treatment. A random sample of the flood

plain cannot be drawn for this purpose, because the areas subject to damage are localized and the concentration of damage per unit of area is high. Appraisal will require specific consideration of each damage area in order that damages may be related to flood stages.

Complete enumeration of damages may be impractical in case a large urban area is flooded. In such an event, an adequate sample should be drawn from the flooded urban areas. Care should be taken that residential sampling represents important value groups of housing. Commercial establishments of the same type may be sufficiently similar in values and susceptibility to damage that samples of each type of establishment may be drawn. But, for example, furniture store damage should not be used to represent supermarket damage. The diversity in industrial plants is such that each usually must be evaluated separately.

When protection of an urban area is a principal project objective, a detailed map of the area subject to flooding should be prepared. Enough valley sections should be surveyed to enable the hydrologist to prepare flood flow lines that will show area flooded by the largest flood of record or the design flood both without and with the project. Such a map will be of use to the economist in evaluating flood damages and benefits from flood reduction.

The map will enable the economist to inventory the damageable value of the property in the flood plain. Upon receipt of information on the area and depth of flooding by floods of various sizes, the economist can coordinate his information into a depth-damage curve for the area.

Although duration of flooding may be a factor in the amount of crop damage sustained, it may have limited effect on many types of nonagricultural damage.

Consideration should be given to the probable future development of the flood plain in urban areas. The tax rolls showing trends in assessed valuation in flood plain may provide useful information. Real estate men usually are in a position to appraise past development and provide some information on existing trends. City officials, such as planning boards, city engineers, city councils, mayors, and city managers, may be excellent sources of information. Organizations, such as chambers of commerce, can be helpful. Some general guidelines for evaluation of future development are given in section IV, A, 2 of this chapter.

Other secondary sources of information such as files of local newspapers will be of value in fixing the limits of floods experienced in the past. They also may contain pictures of the flood

and property damaged. Their appraisals of damage will be useful if the flood is of fairly recent date. If the value of property has changed significantly since the date of occurrence of the flood, the estimate of experienced damage should be adjusted to reflect the new values. Effects of protective measures that have been installed since previous flooding should be examined. Further adjustments for future development and projected price levels will be needed.

a. Roads and Bridges

Estimates of road and bridge damage may be obtained from State highway engineers, boards of county commissioners, county engineers, or township trustees. These data should be related to specific events and depths of flooding. Many times, however, such information is incomplete. A county commissioner may be newly elected and unable to report on the expenditures of his predecessors. Or he may have a certain sum to spend and keep no particular records regarding the proportion spent for ordinary maintenance and that for repair of damage. Recorded damages to roads and bridges may be inaccurate because of delayed maintenance or repair. A road or highway district may have only a budgeted sum for repair or maintenance which may cause total costs to be spread over several years. For these reasons, the sample flood damage schedule carries the question "What damage did this flood do to roads and bridges nearby?" It is believed that this information obtained from farmers and others will provide a check on the data from other sources. Probably they will have little information on costs, but they can pinpoint the location of major bridge and road damage. Furthermore, in some areas, farmers cooperatively repair some of the roads and bridges. When this is the case, the full cost of repairs may not be found in the books of public officials.

When obtaining information on historical damage to roads and bridges, it is necessary to find out the condition of the facility at the time it was damaged. Increased modern traffic and flood hazards often cause replacements to be better and less subject to flood damage than the original facility. When this has occurred or if it seems likely to occur in the future, damage estimates should be based on the new facility.

b. Railroads

Information on damage from severe floods to railroad property usually can be obtained from railroad officials. Caution should be observed in obtaining this information to make sure that it is complete, particularly if only partial repair is made immediately after the flood and complete restoration is deferred. The question also arises, with railroad damage, as to whether or not there is segregation of normal maintenance and flood repair expenditures when less than major floods are concerned.

Ordinarily, it is desirable to obtain as much information as possible from local railroad officials to supplement that obtained from company headquarters. Local people usually can give information on the location of track and bridges damaged and an indication of physical damage. Such information can be correlated with published data and information previously gathered elsewhere.

c. Residential

Flood damages to residences and appurtenances may constitute a large portion of the total flood damage in some watersheds even though no major concentration of population exists and only a few scattered houses in the flood plain are affected. Where this is the situation, damages to residences should be appraised separately in each case by making inquiry of informed residents.

Flood damages to such properties usually include some or all of items as: house, garage, septic tank, lawn, shrubbery, vegetable garden, orchards, sidewalks, fences, and small animal shelters. Mobile equipment on the premises at the time of floods may also be damaged.

Some district offices of the U. S. Corps of Engineers have compiled schedules of average damages to dwellings and contents when flooded to different depths. A study by the Stanford Research Institute contains much useful information. These and similar compilations may be helpful in supplementing data from the field but they should never be relied upon without field investigation to determine if they are applicable.

A damage form or schedule may be prepared to serve as a guide and a check list in estimating losses. When appraising and recording damages it is important to associate the damage with depth of inundation in order that stage-damage relationships may be established. The schedule sample included herein (figure 3.8) indicates the kinds of information required. With some modification it may fit the needs of most watersheds where residential damages occur.

To comply with the need for development of a stage-damage relationship, damage appraisal for several different flood stages is required. The range in flood stage for damage appraisal should extend from the point where damage commences to a stage possibly one or two feet higher than the maximum flood on record. Usually the highest stage for which damages are estimated is that of the 100-year flood.

On streams where flooding of houses is quite frequent, precautions should be taken to determine, (1) if repairs are made following floods and before succeeding floods occur, and (2) if flooded parts of the house or appurtenances are utilized in the normal or

"flood-free" manner. When building values are not maintained and when basements, for example, are not utilized for normal purposes because of frequent flooding, account of these conditions should be taken in adjusting damage appraisals downward from the losses which would occur under normal conditions. As an offset, however, it may be possible that upon protection full use will be made of the property and the value enhanced.

4. Other Floodwater Damage

There may be flood damage of types other than those described here in an occasional watershed. If so, the damage should not be neglected, although special procedures for its evaluation may need to be devised. As an example, flooding may leave stagnant pools in depressions which become breeding places for mosquitoes. The cost of mosquito control, insofar as it stems from this source is a flood damage. Loss of life in the watershed during floods, although not evaluated in monetary terms, should be reported as an intangible damage.

5. Indirect Damage

Indirect damages include certain losses which result from flooding even though the property involved was not flooded. Some examples of such indirect damages follow. An electric power plant is flooded so that power is no longer produced and spoilage takes place in freezers and refrigerators operated by electricity. A bridge is washed out and traffic is forced to detour a considerable distance. A flood causes interruption in the feeding regimen of a livestock producer and, although his livestock were not in the flood, the upset slows down the rate of gain and causes extra expense before they are marketable.

In estimating indirect damage, care must be taken to avoid double counting. For example, a house may be flooded and the family living there may lose its clothing. This loss is a direct damage, but the value of substitute clothing supplied by a relief agency would not be an additional indirect damage.

Information on indirect damages usually is more difficult to obtain than on direct damage. Although some data will be gathered during the course of ordinary damage interviews, it seldom will be complete. Indirect damages are of so many different kinds that neither the economist nor the respondent may think of all possibilities. Experience has indicated that indirect damage often may be expressed as a percentage of the direct. The information from the schedules generally will be sufficient to indicate the portion of the suggested range that is applicable. Considerable latitude may be allowed for special cases. The following percentages of direct damages are suggested for use in estimating indirect damages.

Type of Direct Damage	Percentage Range
Agricultural 1/	5 - 10
Residential	10 - 15
Commercial and Industrial	15 - 20
Highways, Bridges and Railroads	15 - 25
Utilities	15 - 20

1/ The percentage probably will be much higher when irrigation and drainage facilities are damaged. The indirect damage should be determined on a case basis when these facilities are involved.

A special situation often exists in the case of residential housing. In many cities low cost housing tends to occupy the flood plain. When this is true, a special study of indirect damage is needed as the usual relationship between direct and indirect damage may not hold.

In an area exceptionally sensitive to flooding, evacuation may take place as soon as a flood threat arises. Then indirect damage would accrue even though no flooding actually occurred. When a residence is flooded, the direct damage curve generally flattens as greater depths of water are reached. In addition, the indirect damage usually becomes less in proportion to the direct.

IV. BENEFIT EVALUATION

Thus far in this chapter the principles of damage appraisals have been presented and basic appraisal methods have been described. Damage appraisal usually is essential in flood prevention in order that benefits for economic justification may be determined. The determination of flood prevention benefits is described briefly in this section of the chapter.

A. Off-Site Benefits

In general, off-site benefits may be considered as accruing to someone who has no control over the source of damage. In the case of a critical sediment producing area, off-site benefits may result from control of the sediment output in the form of a decrease in rate of channel filling and the resulting flooding downstream. A floodwater retarding structure will create off-site benefits from reduced

flooding on the downstream flood plain. Off-site benefits usually are the principal type of benefit to be derived from flood prevention measures.

1. Reductions in Damage

Flood damages are reduced by a reduction of discharge or an increased channel capacity, which in turn reduces the area, duration, and depth of flooding or the sediment load carried for downstream deposition. Evaluation requires the determination of the damages under non-project conditions and those remaining after land treatment and successive increments of structural measures. The difference between the damage before and after installation of any segment of the project constitutes the benefit from damage reduction creditable to that segment.

In addition to reductions in ordinary physical damage, consideration should be given to the possibility that flood prevention measures sometimes will reduce the cost of operation and maintenance or lengthen the life of proposed or existing facilities. For example, a heavy sediment load in a stream may cause such extensive channel filling that it requires cleaning out at frequent intervals. In this case, benefits could arise from reduction in the cost of cleaning out the channel and would constitute a form of damage reduction benefits.

In the Frequency Method the modified discharge-frequency curve, prepared by the hydrologist, will enable the economist to prepare a modified damage-frequency curve to compare with the non-project or original damage-frequency curve to determine benefits. Modified curves prepared by the economist and hydrologist are necessary for each kind or combination of measures being evaluated.

The same principle is involved in the Historical Series Method. The total difference in damages over the evaluation period, adjusted for recurrence, is divided by the number of years in the series to determine average annual damages. This is required for each kind or combination of measures being evaluated for comparison with the non-project or original damage.

Benefits from reduction in damage as a result of flood prevention measures generally begin to accrue as soon as the measures are installed and need no discounting for time lag. The chief exceptions will be when areas are restored to their former productivity. If there is land damage from sediment deposition or flood plain scour, time will be required for recovery. Likewise, if frequent flooding has caused a shift to land use less susceptible to flood damage, operators of flood plain lands can be expected to wait until they can judge the effectiveness of their protection before they restore the area to its former use. Proper discounting should be considered for such benefits when significant time lags are involved.

When reduction in land damage is used as a benefit, appropriate adjustments in estimates of other types of damage should be made.

As an example, when flood plain land is destroyed through stream bank erosion, the estimate of crop and pasture damage during the life of the project must be reduced to take into account the progressively smaller area that will remain to sustain damage.

A technical problem that arises in the evaluation of the benefits from waterflow control measures is the collaboration between the hydrologist and the economist in determining the acreages involved. The flood routing to determine damages under non-project conditions and after land treatment measures have been installed may be done before floodwater retarding structure sites have been determined. When these sites have been located finally, it may be that part of the flood plain on which previous routing has been made will be included within the pool area of the structure. Unless adjustments are made, the difference between damages before and after project installation would include the damage within the pool area as a project benefit. Adjustments of a similar nature also will be needed when channel improvement or floodways are planned and their benefits are evaluated.

2. Future Development in the Absence of a Project

As discussed earlier in this chapter, project evaluation requires a comparison of conditions which would exist over the project life in the absence of the project with those that can be expected with the project in operation. In nearly every project, therefore, the damageable value base from which evaluation is to be made will be different from the present situation.

The most common approach to this problem is to estimate the eventual degree of change, the period over which the change will occur, and assume that the change will take place uniformly over time. This will provide an annual increment of change which can be discounted to present worth and used to adjust the present to average future conditions.

It is worth noting that the use of a simple average of the existing and eventual values for this purpose is unsound because deferred values are worth less than similar values at hand. Consequently, when damageable values are increasing, the greatest value will be at the end of the time period and will receive the heaviest discount. The average annual equivalent values after discounting, then will be less than the simple average of values. The reverse is true if damageable values are declining. (For a more complete discussion, see Appendix A).

In an expanding economy it can be expected that values generally will increase. Improving technology and the pressure from increasing population will encourage increased agricultural production per unit of area. Values in existing developments will increase because of new products and a higher standard of living. Urbanization will cause urban areas and the suburban fringes to encroach upon areas now in agriculture. Although this will be the usual situation, there will be cases where values will decline. Changes in diet and cost-price

relationships may encourage shifts of some areas from cash crop to livestock production. Small rural communities may decline in importance as improved travel makes larger centers more accessible. Consequently adjustments to account for future development may involve either increases or declines in damageable values.

Changes in development without a project should not be confused with the enhancement-type benefits caused by the project, described in Chapter 4.

3. Increased Income

The flood hazard often prevents the highest use of resources. Once the hazard is removed, these resources probably will be used more effectively. For example, a flood plain pasture is little used because of the hazard to livestock. So-called "catch crops" are being grown instead of high value crops in an effort to avoid the season of worst flooding. These are examples of situations where protection may allow land to remain in its original use but income will be increased through more effective use of resources.

Protection also may allow land to be converted to higher, more productive uses. Perhaps brush will be cleared and a frequently flooded field will be converted to cropland after effective protection. Or unused land in an urban area will be shifted to industrial or other use.

Changes of these types usually will take place only after some lag in time. Benefits calculated therefrom should be discounted accordingly.

The increased net income resulting from such changes is a benefit derived from flood prevention. Associated costs required to make such changes possible should be deducted from the gross increase in income.

Special consideration should be given to certain situations in evaluating enhancement-type benefits. Included among these are the following:

a. Sometimes flood plain production will be increased through moving crops from upland areas less suited to their production down to the fertile flood plain. The upland area is shifted to a less intensive use. When this is done, the increased income from the flood plain may be offset partially by reduced income in the upland area.

b. In an urban area there may be expansion of industry, business, or residential developments into the flood plain after protection. Had there been no protection, the total expansion might have been about the same but it would have been into other areas, perhaps the agricultural fringe around the city. Here the enhancement benefit would be only from the advantage the flood plain would have over the alternative areas in such things as economy of development or use.

c. Special care must be taken to distinguish between enhancement resulting from the project and future development that will take place without the project, because of the possibility of double counting. Often a separation by geographical areas where only one or the other is anticipated will be helpful. Evaluation of these enhancement-type benefits is discussed in some detail in Chapter 4.

4. Remaining Damage to Higher Values

An attempt to provide complete flood protection ordinarily will not be economic. It may even be physically impossible. If the project is installed and the flood plain is used more intensively as a result, it can be expected that remaining floods will cause more damage than they would under the original land use. The increased income from restoration, intensification or changed land use should be adjusted to account for this condition.

Adjustments may be made either for the frequency or the historical methods by using the new damageable values and the flooding from the remaining events. Experience will indicate appropriate shortcuts that can be used to fit a given situation.

B. On-site Benefits

On-site benefits are those that accrue at the general location of the control measure.

Many land stabilization measures produce on-site as well as off-site benefits. Vegetative plantings on critical sediment source areas may increase the net return from cropping, grazing, or wildlife production. Stabilization may preserve the full value of land that otherwise would be encroached upon by gullies. Sometimes installation of land treatment measures would not be feasible without first installing measures for stabilizing gullies. Increased net returns that occur on the drainage area of the structures over the amount that could be obtained without structural stabilization measures are creditable to the structural measures. Such benefits may be largely in the form of reduced crop or livestock income losses or increased crop or livestock returns. Details of the evaluation of land damage from erosion and sediment deposition may be found in Chapter 5. The cost of the necessary land treatment measures, when their installation is made possible because of the stabilization measures, should be handled as an associated cost.

Such waterflow control measures as detention-type terraces and water-spreading devices may give important on-site benefits. These benefits may be measured through an approach similar to that described above for land stabilization measures.

On-site benefits may be available within the site of a floodwater retarding structure. Such benefits may accrue from fish culture,

recreation, and use of the sediment pool for stockwater, irrigation or domestic water supply. Evaluation of the benefits from other uses should take into account the fact that the sediment pool is designed to store sediment and its ability to furnish incidental benefit will decline through the project life. Any benefits claimed should be discounted on this account. Evaluation of benefits when used incidentally for irrigation should recognize the fact that the sediment pool cannot be expected to furnish a fully dependable water supply for this purpose. Evaluation of on-site benefits from incidental use of floodwater retarding structures should take cognizance of State laws regarding water use. For example, in some states prior appropriation has been made for certain downstream uses and provision has to be made for drainage of the sediment pool on demand. Under these conditions no firm on-site benefits can be claimed for its use.

V. COSTS

Economic analysis involves the comparison of the costs of a project with the benefits which it produces. Both are reduced to equivalent time values. This may be done either by capitalization of periodic benefits and costs to place them on the same basis as capital outlays, or by converting capital sums to their annual equivalent through amortization. The latter is the usual procedure.

Costs may be divided into two main groups - project costs and associated costs.

A. Project Costs

These costs include all costs incurred in project installation, operation and maintenance which are to be compared with project benefits.

1. Installation Costs

Included in the project installation costs are all costs of construction, including design, engineering, inspection and an allowance for contingency. The value of lands, easements, rights-of-way, and the cost of relocating facilities that must be moved because of the installation are included.

At times sites may be purchased. In this case the funds expended are a measure of the cost. In other cases, the estimate of value by the local organization, with the concurrence of the Service, will be used for determining the value of the site. Even when sites are donated, there usually is a cost to someone although this may be offset in whole or in part by incidental benefits from the new use of the site. Some of the considerations inherent in site cost evaluation are discussed in Chapter 13, Land, Easements, and Rights-of-Way.

Installation costs are capital expenditures incurred during project installation. As such, unless there is a prolonged installation

period, current price levels should be used. In case any one structure in a project will require a prolonged period (over two years) for its installation, interest on the average investment during this period becomes a part of the installation cost. Ordinarily this will not be applicable to small watershed projects. For comparison with project benefits, installation costs are amortized over the project life. Although not usually applicable to flood prevention projects, if salvage values remain after the end of the project life appropriate deductions in costs may be considered.

2. Operation and Maintenance Costs

The cost of maintaining works of improvement in such a condition that they will deliver the full benefit for which they were designed is another cost component. Maintenance costs may vary from year to year, however, in economic appraisal the best estimate that can be made of average costs over the period of analysis should be used. Normally, the longer the project life, the more should be allowed for project maintenance.

Sometimes a project will have facilities which must be replaced during the life of the project. The original cost of such facilities will be included in the project installation cost and amortized over the project life. Provision for replacement will be made by inclusion of sufficient funds for this purpose in the maintenance cost of the project.

Another item of annual cost is operation of the works of improvement. When automatically operating measures, such as drop inlets or floodwater retarding structures, are concerned operating costs are generally nil. Such costs should be considered when manually operated gates and similar types of equipment are involved.

3. Induced Costs

These costs include all uncompensated adverse effects in goods and services caused by the construction or operation of a project.

A typical example would be the value of the loss in production on lands taken for project purposes that is in excess of the payment therefor or the estimated easement value. Thus if the estimated amortized easement value is $5,000 but the loss in agricultural production is $6,000 annually, the difference, $1,000 annually, is another economic cost of the project and should be included with project costs.

In calculating the loss of net income in agricultural areas to be used for project purposes, items to consider include: non-project land uses and yields compared with those attained with the project, flood damage to non-project uses, and taxes and overhead costs. Among the types of measures where these items may be significant are: fencing and exclusion of use in critical sediment source areas; the pools, embankment, and spillway of floodwater retarding structures; the channel and spoil disposal areas for channel improvement, etc.

It is not likely that flood prevention measures normally will be so located that they will displace production from industrial, mining or urban areas. If they are so located, adequate accounting should be made of the production lost.

If channel improvement or other similar waterflow control measures are terminated at a point where possible floodwater, sediment or erosion damages may be induced downstream, such damages should be considered as induced by the project. Sometimes flowage easements may provide a financial measure of these costs. If such costs are not adequate, the excess would be a form of "Other Economic Costs" of the project.

In some cases project installation may induce damage to fish and wildlife resources.

Whenever induced damages are caused, either measures should be incorporated into the project to alleviate these damages, or they should be counted as a tangible or intangible cost of the project.

B. Associated Costs

Associated costs may be considered as the value of goods and services needed over and above project costs to make the immediate products of the project available for use or sale. They are usually considered as deductions from benefits.

In flood prevention, associated costs are involved chiefly in calculating benefits from changed land use. Associated costs connected with changed use of the land, such as provision of streets and utilities in urban areas, or conversion from pasture to cropland, clearing woods, farm drainage and the like on agricultural land, are amortized and deducted from the increased income. It is possible that additional barns, granaries and equipment may be needed to handle the additional production. Thus associated costs may include an item for increased taxes and overhead. The increase in the cost of farm operations involved in crop production forms another item of associated costs for deduction from the increase in gross income.

When land treatment measures are required to realize the benefits from structural measures, the cost of the necessary land treatment becomes an associated cost. Such a case might arise if flood protection enables a farmer to level his land and install on-farm drainage or irrigation. Here land leveling and the on-farm drainage or irrigation systems would become associated costs.

The treatment of the direct costs of crop production is a little different in damage analysis. When a crop is destroyed by a flood, the full cost of operations yet to be performed is subtracted from the damage as expense not incurred. If the crop is flooded early and replanting is necessary, the full cost of the added operations is

included in the damage estimate. The term "full cost" includes the value of unpaid family labor and interest and depreciation on machinery as well as out-of-pocket cash costs.

Although associated costs do not appear in the benefit-cost ratio, their careful appraisal is most important. Because they are deducted from the gross benefit, they determine the size of the benefit used in economic analysis. They have almost equal importance as a supplementary economic tool in determining whether appraisals of damage and benefits are realistic. For example, the spread between gross income and associated costs is of high importance in estimating the amount of damage a farmer will take before letting his flood plain lands lie idle, and the degree of protection he will require before he intensifies his land use.

Alfalfa - April through September

Pasture - April through September

Sugar Beets - April through September

Corn Silage - May 15 to September 15

Small Grain - May to July 15

Composite acre water requirement:

Crop	Land Use	April	May	June	July	August	Sept.	
Corn S.	10		.15	.27	.48	.47	.15	
Sugar B.	20	.40	.49	.40	.80	.79	.51	
Sm. Grain	10		.27	.23	.22			
Pasture	20	.44	.55	.47	.87	.86	.56	
Alfalfa	40	.96	1.21	1.08	1.91	1.86	1.23	
Total	100	1.80	2.67	2.45	4.28	3.98	2.45	17.63

Value added per inch of irrigation water supplied

113.90 ÷ 17.63 = $6.46

Value added per month

April	May	June	July	August	Sept.	Total
$11.63	$17.25	$15.83	$27.65	$25.71	$15.83	$113.90

Value added per day

.39	.56	.53	.89	.83	.53

Damage per composite acre from a 15 day break in:

5.85	8.40	7.95	13.35	12.45	7.95

Weighted damage per composite acre:

Month	Damage		Monthly Storm Distribution		
April	5.85	x	5	=	
May	8.40	x	22	=	
June	7.95	x	33	=	
July	13.35	x	17	=	
August	12.45	x	10	=	
September	7.95	x	5	=	
Total					$ 8.68

This $8.68 is the weighted damage per composite acre per break. The average annual damage from delay in water delivery is equal to number of acres served times damage per acre times the storm frequency required to cause the canal to fail. (This assumes that the breaks from more infrequent storms do not require longer to repair.)

If in the above example this canal serves 1500 acres, the average annual damages would then be:

1500 acres x $8.68 x 6% = $781.20

RESIDENCE FLOOD DAMAGE TABLE

Current Dollar Value	Items	Total Value of Furniture	Basement Damage	Dollar Damage at Depth Flooded Over First Floor																		
				.0-.4'	.5'-1.4'	1.5'-2.0'	2.5'	3.0'	3.5'	4.0'	4.5'	5.0'	5.5'	6.0'	6.5'	7.0'	7.5'	8.0'	8.5'	9.0'	9.5'	10'
$1,000	Floors & Walls			$ 75	$ 85	$ 95	$ 105	$ 115	$ 125	$ 135	$ 140	$ 150	$ 160	$ 170	$ 180	$ 190	$ 200	$ 250	$ 250	$ 250	$ 250	$ 250
	Furniture	$ 330		165	215	250	250	250	260	265	275	280	280	280	280	280	280	280	280	280	280	280
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		$ 110	400	460	505	520	530	555	570	590	605	620	630	645	655	670	720	725	725	730	730
1,500	Floors & Walls			110	125	140	155	170	185	200	210	225	240	255	270	285	300	375	375	375	375	375
	Furniture	495		240	310	360	365	370	385	395	410	420	420	420	420	420	420	420	420	420	420	420
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		120	520	605	670	695	715	750	775	805	830	850	865	885	900	920	995	1000	1000	1005	1005
2,000	Floors & Walls			150	170	190	210	225	245	265	285	305	325	340	360	380	400	500	500	500	500	500
	Furniture	660		315	405	475	485	495	515	530	545	560	560	560	560	560	560	560	560	560	560	560
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		130	645	755	845	880	905	950	985	1025	1060	1085	1100	1125	1145	1170	1270	1275	1275	1280	1280
2,500	Floors & Walls			185	210	235	260	280	305	330	355	380	405	430	450	475	500	625	625	625	625	625
	Furniture	830		380	500	590	605	620	645	665	685	705	705	705	705	705	705	705	705	705	705	705
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		140	755	900	1015	1060	1095	1150	1195	1245	1290	1320	1345	1370	1395	1425	1550	1555	1555	1560	1560
3,000	Floors & Walls			220	250	280	310	335	365	395	425	455	485	510	540	570	600	750	750	750	750	750
	Furniture	1000		450	600	700	725	750	750	800	825	850	850	850	850	850	850	850	850	850	850	850
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		150	870	1050	1180	1240	1290	1325	1405	1465	1520	1555	1580	1615	1645	1680	1830	1835	1835	1840	1840
3,500	Floors & Walls			255	290	325	360	390	425	460	495	530	565	595	630	665	700	875	875	875	875	875
	Furniture	1150		505	670	785	825	865	895	920	950	980	980	980	980	980	980	980	980	980	980	980
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		160	970	1170	1320	1400	1470	1540	1600	1670	1735	1775	1805	1845	1880	1920	2095	2100	2100	2105	2105
4,000	Floors & Walls			290	330	370	410	445	485	525	565	605	645	680	720	760	800	1000	1000	1000	1000	1000
	Furniture	1300		560	740	870	925	975	1010	1040	1075	1105	1105	1105	1105	1105	1105	1105	1105	1105	1105	1105
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		165	1065	1285	1455	1555	1640	1720	1790	1870	1940	1985	2020	2065	2105	2150	2350	2355	2355	2360	2360
4,500	Floors & Walls			330	375	420	460	505	550	595	635	680	725	770	810	855	900	1125	1125	1125	1125	1125
	Furniture	1475		620	825	960	1035	1105	1145	1180	1220	1255	1255	1255	1255	1255	1255	1255	1255	1255	1255	1255
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		175	1175	1425	1605	1725	1840	1930	2010	2095	2175	2225	2270	2315	2360	2410	2635	2640	2640	2645	2645
5,000	Floors & Walls			375	425	470	520	570	615	665	710	760	810	860	905	950	1000	1250	1250	1250	1250	1250
	Furniture	1650		680	910	1050	1145	1240	1280	1320	1365	1405	1405	1405	1405	1405	1405	1405	1405	1405	1405	1405
	Lawn			50	50	50	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90
	TOTAL w/Basement		185	1290	1570	1755	1905	2050	2140	2230	2325	2415	2470	2520	2570	2615	2670	2720	2725	2725	2730	2730
5,500	Floors & Walls			410	465	515	560	625	675	730	780	835	890	940	995	1045	1100	1375	1375	1375	1375	1375
	Furniture	1825		730	985	1130	1250	1370	1415	1460	1505	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
	Lawn			55	55	55	60	60	65	65	70	70	75	75	80	80	85	85	90	90	95	95
	TOTAL w/Basement		190	1385	1695	1890	2070	2245	2345	2445	2545	2645	2705	2755	2815	2865	2925	3200	3205	3205	3210	3210
6,000	Floors & Walls			440	500	555	615	675	735	790	850	910	965	1025	1085	1140	1200	1500	1500	1500	1500	1500
	Furniture	2000		780	1060	1210	1355	1500	1550	1600	1650	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
	Lawn			60	60	60	65	65	70	70	75	75	80	80	85	85	90	90	95	95	100	100
	TOTAL w/Basement		200	1480	1820	2025	2235	2440	2555	2660	2775	2885	2945	3005	3070	3125	3190	3490	3495	3495	3500	3500

RESIDENCE FLOOD DAMAGE TABLE (Contd.)

Current Dollar Value	Items	Total Value of Furniture	Basement Damage	Dollar Damage at Depth Flooded Over First Floor																		
				.0'-.4'	.5'-1.4'	1.5'-2.0'	2.5'	3.0'	3.5'	4.0'	4.5'	5.0'	5.5'	6.0'	6.5'	7.0'	7.5'	8.0'	8.5'	9.0'	9.5'	10'
6,500	Floors & Walls	2150		475	540	600	665	730	795	855	920	985	1045	1110	1175	1235	1300	1625	1625	1625	1625	1625
	Furniture			815	1105	1270	1445	1615	1670	1720	1775	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830
	Lawn			65	65	65	70	70	75	75	80	80	85	85	90	90	95	95	100	100	105	105
	TOTAL w/Basement		210	1565	1920	2145	2390	2625	2750	2860	2985	3105	3170	3235	3305	3365	3435	3760	3765	3765	3770	3770
7,000	Floors & Walls	2300		510	580	645	715	785	855	920	990	1060	1125	1195	1265	1330	1400	1750	1750	1750	1750	1750
	Furniture			850	1150	1330	1530	1725	1785	1840	1900	1955	1955	1955	1955	1955	1955	1955	1955	1955	1955	1955
	Lawn			70	70	70	75	75	80	80	85	85	90	90	95	95	100	100	105	105	110	110
	TOTAL w/Basement		225	1655	2025	2270	2545	2810	2945	3065	3200	3325	3395	3465	3540	3605	3680	4030	4035	4035	4040	4040
8,000	Floors & Walls	2650		580	660	735	815	895	975	1050	1130	1210	1285	1365	1445	1520	1600	2000	2000	2000	2000	2000
	Furniture			925	1270	1450	1720	1990	2055	2120	2190	2255	2255	2255	2255	2255	2255	2255	2255	2255	2255	2255
	Lawn			80	80	80	85	85	90	90	95	95	100	100	105	105	110	110	115	115	120	120
	TOTAL w/Basement		250	1835	2260	2515	2870	3220	3370	3510	3665	3810	3890	3970	4055	4130	4215	4615	4620	4620	4625	4625
9,000	Floors & Walls	3000		640	730	820	910	995	1085	1175	1265	1355	1445	1535	1620	1710	1800	2250	2250	2250	2250	2250
	Furniture			1020	1380	1560	1905	2250	2325	2400	2475	2550	2550	2550	2550	2550	2550	2550	2550	2550	2550	2550
	Lawn			90	90	90	95	95	100	100	105	105	110	110	115	115	120	120	125	125	130	130
	TOTAL w/Basement		275	2025	2475	2745	3185	3615	3785	3950	4120	4285	4380	4470	4560	4650	4745	5195	5200	5200	5205	5205
0,000	Floors & Walls	3300		685	785	890	990	1090	1190	1290	1395	1495	1595	1695	1800	1900	2000	2500	2500	2500	2500	2500
	Furniture			1090	1480	1680	2080	2475	2560	2640	2725	2805	2805	2805	2805	2805	2805	2805	2805	2805	2805	2805
	Lawn			100	100	100	105	105	110	110	115	115	120	120	125	125	130	130	135	135	140	140
	TOTAL w/Basement		305	2180	2670	2975	3480	3975	4165	4345	4540	4720	4825	4925	5035	5135	5240	5740	5745	5745	5750	5750
1,000	Floors & Walls	3650		735	850	960	1075	1185	1300	1410	1525	1635	1750	1860	1975	2085	2200	2750	2750	2750	2750	2750
	Furniture			1170	1610	1820	2280	2740	2830	2920	3015	3105	3105	3105	3105	3105	3105	3105	3105	3105	3105	3105
	Lawn			110	110	110	115	115	120	120	125	125	130	130	135	135	140	140	145	145	150	150
	TOTAL w/Basement		345	2360	2915	3235	3815	4385	4595	4795	5010	5210	5330	5440	5560	5670	5790	6340	6345	6345	6350	6350
2,000	Floors & Walls	4000		775	900	1025	1150	1275	1400	1525	1650	1775	1900	2025	2150	2275	2400	3000	3000	3000	3000	3000
	Furniture			1240	1720	1960	2480	3000	3100	3200	3300	3400	3400	3400	3400	3400	3400	3400	3400	3400	3400	3400
	Lawn			120	120	120	125	125	130	130	135	135	140	140	145	145	150	150	155	155	160	160
	TOTAL w/Basement		390	2525	3130	3495	4145	4790	5020	5245	5475	5700	5830	5955	6085	6210	6340	6940	6945	6945	6950	6950
3,000	Floors & Walls	4300		820	955	1095	1230	1370	1505	1640	1780	1915	2050	2190	2325	2465	2600	3250	3250	3250	3250	3250
	Furniture			1290	1805	2065	2645	3225	3335	3440	3550	3655	3655	3655	3655	3655	3655	3655	3655	3655	3655	3655
	Lawn			130	130	130	135	135	140	140	145	145	150	150	155	155	160	160	165	165	170	170
	TOTAL w/Basement		425	2665	3315	3715	4435	5155	5405	5645	5900	6140	6280	6420	6560	6700	6840	7490	7495	7495	7500	7500
,000	Floors & Walls	4600		860	1010	1160	1310	1455	1605	1755	1905	2055	2205	2350	2500	2650	2800	3500	3500	3500	3500	3500
	Furniture			1330	1890	2160	2805	3450	3565	3680	3795	3910	3910	3910	3910	3910	3910	3910	3910	3910	3910	3910
	Lawn			140	140	140	145	145	150	150	155	155	160	160	165	165	170	170	175	175	180	180
	TOTAL w/Basement		460	2790	3500	3920	4720	5510	5780	6045	6315	6580	6735	6880	7035	7185	7340	8040	8045	8045	8050	8050
,000	Floors & Walls	4950		900	1060	1225	1385	1545	1710	1870	2030	2190	2355	2515	2675	2840	3000	3750	3750	3750	3750	3750
	Furniture			1390	1980	2280	3000	3715	3840	3960	4085	4210	4210	4210	4210	4210	4210	4210	4210	4210	4210	4210
	Lawn			150	150	150	155	155	160	160	165	165	170	170	175	175	180	180	185	185	190	190
	TOTAL w/Basement		505	2945	3695	4160	5045	5920	6215	6495	6785	7070	7240	7400	7565	7730	7895	8645	8650	8650	8655	8655
,000	Floors & Walls	5280		960	1140	1310	1470	1650	1820	2000	2160	2340	2510	2690	2850	3020	3200	4000	4000	4000	4000	4000
	Furniture			1490	2110	2432	3200	3970	4100	4220	4350	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500
	Lawn			160	160	160	160	160	180	180	180	180	180	180	190	190	190	190	190	190	210	210
	TOTAL w/Basement		540	3150	3950	4442	5370	6320	6640	6940	7230	7560	7730	7910	8080	8250	8430	9230	9230	9230	9250	9250

RESIDENCE FLOOD DAMAGE TABLE (Contd.)

Current Dollar Value	Items	Total Value of Furniture	Basement Damage	Dollar Damage at Depth Flooded Over First Floor																		
				.0'-.4'	.5'-1.4'	1.5'-2.0'	2.5'	3.0'	3.5'	4.0'	4.5'	5.0'	5.5'	6.0'	6.5'	7.0'	7.5'	8.0'	8.5'	9.0'	9.5'	10'
17,000	Floors & Walls	5610		1020	1210	1390	1560	1750	1940	2120	2300	2480	2670	2860	3030	3210	3400	4250	4250	4250	4250	4250
	Furniture			1580	2240	2580	3400	4220	4350	4490	4620	4780	4780	4780	4780	4780	4780	4780	4780	4780	4780	4780
	Lawn			170	170	170	170	170	190	190	190	190	190	190	200	200	200	200	200	200	220	220
	TOTAL w/Basement		580	3350	4200	4720	5710	6720	7060	7380	7690	8030	8220	8410	8590	8770	8960	9810	9810	9810	9830	9830
18,000	Floors & Walls	5940		1080	1280	1480	1660	1850	2050	2250	2430	2630	2830	3020	3200	3400	3600	4500	4500	4500	4500	4500
	Furniture			1670	2380	2740	3600	4460	4610	4750	4900	5060	5060	5060	5060	5060	5060	5060	5060	5060	5060	5060
	Lawn			180	180	180	180	180	200	200	200	200	200	200	220	220	220	220	220	220	230	230
	TOTAL w/Basement		610	3540	4450	5010	6050	7100	7470	7810	8140	8500	8700	8890	9090	9290	9490	10390	10390	10390	10400	10400
19,000	Floors & Walls	6270		1140	1350	1560	1750	1960	2170	2380	2560	2770	2980	3190	3380	3590	3800	4750	4750	4750	4750	4750
	Furniture			1770	2510	2890	3800	4710	4860	5020	5170	5340	5340	5340	5340	5340	5340	5340	5340	5340	5340	5340
	Lawn			190	190	190	190	190	210	210	210	210	210	210	230	230	230	230	230	230	250	250
	TOTAL w/Basement		650	3750	4700	5290	6390	7510	7890	8260	8590	8970	9180	9390	9600	9810	10020	10970	10970	10970	10990	10990
20,000	Floors & Walls	6600		1200	1420	1640	1840	2060	2280	2500	2700	2920	3140	3360	3560	3780	4000	5000	5000	5000	5000	5000
	Furniture			1860	2640	3040	4000	4960	5120	5280	5440	5620	5620	5620	5620	5620	5620	5620	5620	5620	5620	5620
	Lawn			200	200	200	200	200	220	220	220	220	220	220	240	240	240	240	240	240	260	260
	TOTAL w/Basement		680	3940	4940	5560	6720	7900	8200	8480	9040	9440	9660	9880	10100	10320	10540	11540	11540	11540	11560	11560
21,000	Floors & Walls	6930		1260	1490	1720	1930	2160	2390	2625	2840	3070	3300	3530	3740	3970	4200	5250	5250	5250	5250	5250
	Furniture			1950	2770	3190	4200	5210	5380	5540	5710	5900	5900	5900	5900	5900	5900	5900	5900	5900	5900	5900
	Lawn			210	210	210	210	210	230	230	230	230	230	230	250	250	250	250	250	250	270	270
	TOTAL w/Basement		710	4130	5180	5830	7050	8290	8710	9105	9490	9910	10140	10370	10600	10830	11060	12110	12110	12110	12130	12130
22,000	Floors & Walls	7260		1320	1560	1800	2020	2270	2510	2750	2970	3210	3450	3700	3920	4160	4400	5500	5500	5500	5500	5500
	Furniture			2050	2900	3340	4400	5460	5630	5810	5980	6180	6180	6180	6180	6180	6180	6180	6180	6180	6180	6180
	Lawn			220	220	220	220	220	240	240	240	240	240	240	260	260	260	260	260	260	290	290
	TOTAL w/Basement		750	4340	5430	6110	7390	8700	9130	9550	9940	10380	10620	10870	11110	11350	11590	12690	12690	12690	12720	12720
23,000	Floors & Walls	7590		1380	1630	1890	2120	2370	2620	2875	3100	3360	3610	3860	4090	4350	4600	5750	5750	5750	5750	5750
	Furniture			2140	3040	3500	4600	5700	5890	6070	6260	6460	6460	6460	6460	6460	6460	6460	6460	6460	6460	6460
	Lawn			230	230	230	230	230	250	250	250	250	250	250	280	280	280	280	280	280	300	300
	TOTAL w/Basement		780	4530	5680	6400	7730	9080	9540	9975	10390	10850	11100	11350	11610	11870	12120	13270	13270	13270	13290	13290
24,000	Floors & Walls	7920		1440	1700	1970	2210	2470	2740	3000	3240	3500	3770	4030	4270	4540	4800	6000	6000	6000	6000	6000
	Furniture			2230	3170	3650	4800	5950	6140	6340	6530	6740	6740	6740	6740	6740	6740	6740	6740	6740	6740	6740
	Lawn			240	240	240	240	240	260	260	260	260	260	260	290	290	290	290	290	290	310	310
	TOTAL w/Basement		820	4730	5930	6680	8070	9480	9960	10420	10850	11320	11590	11850	12120	12390	12650	13850	13850	13850	13870	13870
25,000	Floors & Walls	8250		1500	1780	2050	2300	2580	2850	3120	3380	3650	3920	4200	4450	4720	5000	6250	6250	6250	6250	6250
	Furniture			2320	3300	3800	5000	6200	6400	6600	6800	7020	7020	7020	7020	7020	7020	7020	7020	7020	7020	7020
	Lawn			250	250	250	250	250	270	270	270	270	270	270	300	300	300	300	300	300	320	320
	TOTAL w/Basement		850	4920	6180	6950	8400	9880	10370	10840	11300	11790	12060	12340	12620	12890	13170	14420	14420	14420	14440	14440
26,000	Floors & Walls	8580		1560	1850	2130	2390	2680	2960	3250	3510	3800	4080	4370	4630	4910	5200	6500	6500	6500	6500	6500
	Furniture			2420	3430	3950	5200	6450	6660	6860	7070	7310	7310	7310	7310	7310	7310	7310	7310	7310	7310	7310
	Lawn			260	260	260	260	260	290	290	290	290	290	290	310	310	310	310	310	310	340	340
	TOTAL w/Basement		880	5120	6420	7220	8730	10270	10790	11280	11750	12280	12560	12850	13130	13410	13700	15000	15000	15000	15030	15030
27,000	Floors & Walls	8910		1620	1920	2210	2430	2780	3080	3380	3640	3940	4240	4540	4810	5100	5400	6750	6750	6750	6750	6750
	Furniture			2510	3560	4100	5400	6700	6910	7130	7340	7590	7590	7590	7590	7590	7590	7590	7590	7590	7590	7590
	Lawn			270	270	270	270	270	300	300	300	300	300	300	320	320	320	320	320	320	350	350
	TOTAL w/Basement		920	5320	6670	7500	9070	10670	11210	11730	12200	12750	13050	13350	13640	13930	14230	15580	15580	15580	15610	15610

CHAPTER 4

EVALUATION OF RESTORATION OF FORMER PRODUCTIVITY, CHANGED LAND USE AND MORE INTENSIVE USE OF BENEFITED LAND

This chapter deals specifically with evaluation of enhancement-type benefits, including restoration of former productivity, changed land use, and more intensive use of benefited areas. It illustrates some of the major types of problems that are likely to be encountered in evaluating these items. It outlines some considerations in projections of crops under acreage allotments and marketing quotas. The discussion herein is applicable to projects for flood prevention and agricultural water management. The basic principles also may be applied in considering benefits from recreation and fish and wildlife and secondary benefits.

I. GENERAL

A. Agricultural Benefits

Many areas of flood plain land were once in cultivation or pasture but now are abandoned or in low income-producing uses because of adverse effects of flooding. The reduced income from such a condition may be considered a type of flood damage. One farmer may take his field out of cultivation because of this hazard while his neighbor, although experiencing the same severity of flooding, is continuing his attempt to cultivate and is experiencing heavy flood losses. Installation of flood prevention measures reduces the flood hazard sufficiently to induce the first farmer to restore his flood plain to a use consistent with its former productivity while the second farmer finds his flood losses reduced. The difference in the net income received by the first farmer between that which he now is receiving and that which can be expected under the restored condition, is a benefit from "restoration of former productivity". It can be seen that such benefits, although they may be evaluated much the same as a true enhancement benefit, are allied conceptually with benefits from damage reduction. For this reason they usually are reported as damage reduction benefits.

Benefits from restoration of former productivity should not be confused with those obtained from changing the use of land that has never been in cultivation, but which may be put into cultivation as a result of the project. For example, if land that has always been in woods, pasture or wild land, is converted to cropland as a result of the project, the benefits resulting would be classed as derived from "changed land use". Ordinarily there are policy restrictions on the extent to which these benefits may be used for project justification. Such restrictions usually apply to putting new land into production in the case of agricultural water management, and to increasing the acreages of certain crops.

Another type of benefit that may result, is an intensification of present use. The flood hazard may deter the operator from using the land

as intensively as he would if there were no flooding. For example, if the flooding were reduced so the added investment were profitable, he might shift land presently in small grain to alfalfa. Or he might use fertilizer and seed to improve low producing pasture. This type of benefit may be predominant in drainage and irrigation projects. The intensity of use in similar nearby watersheds where flooding, wet lands, or lack of water are not problems may be used to guide the estimate of intensity of use when these hazards are removed in the watersheds under consideration. Benefits of this type are classified as benefits from "more intensive use".

B. Non-agricultural Benefits

Enhancement-type benefits may accrue to the non-agricultural community as a result of a project. Primary benefits of this type are likely to come from measures for flood prevention although there may be enhancement-type benefits from nearly any type project.

Flood protection may permit business, industrial, or residential development of flood plain areas where there is risk of flooding without protection. Such areas often are level and can be developed much cheaper than nearby uplands. The development may take the form of a shift from agricultural to rural residences, suburban or urban use. It may involve development of idle land or land in a low order of use within urban limits.

The preferred method of evaluating benefits of this type is through the annual equivalent of the increased value of the land. If data are not available, an alternative method is the increase in the net rental income from the land. These approaches apply when industrial, commercial or residential development is concerned. In most instances there would be an opportunity for the same type of development elsewhere. If benefits are claimed for the project, the development in the benefited area should have advantages over outside development in terms of higher income, lower development costs, or both. Only the difference between the project and other development net values after development costs are deducted can be considered a project benefit.

A variant of this situation may occur when the project permits development of the benefited area for public use. Perhaps a highway can be constructed along a flood plain much cheaper than through the upland. The saving in cost would be the benefit. Sometimes the protected area may be converted into a park. Here the benefit may be measured in the form of an apportunity cost or as a direct recreational benefit. The opportunity cost approach would involve measurement of values foregone in some other use if the park development were located elsewhere, assuming approximately equal park facilities. Sometimes the protected area will possess unique advantages for recreation and the benefits can be measured directly. Evaluation of recreational benefits is discussed more fully in chapter 9.

Because of the high investment and the concentration of people involved in non-agricultural developments a higher degree of protection can be justified than for the typical agricultural project.

II. BASIC DATA NECESSARY FOR EVALUATION

Evaluation of benefits of the types described in this chapter is complex and requires a thorough study of the individual watershed.

Identification of the areas on which these benefits may accrue is essential. Several physical, social and economic factors govern the amount of change, restoration or intensification that will result and when the expected change will occur. Information on at least the following factors should be obtained and evaluated.

1. Potential of the land.
2. Type of farming.
3. Width and topography of the flood plain or area to be benefited.
4. Need for various types of production, whether in agricultural products or in urban and industrial services as the case may be.
5. Degree of protection or service afforded by the improvements.
6. The change supported by this degree of protection or service.
7. Willingness, intentions, financial and managerial ability of present and future operators to develop the land.
8. Availability of markets for any new products.
9. Restrictions imposed by acreage allotments, marketing quotas or zoning regulations.

For agricultural purposes the productivity of the land and its responsiveness to production inputs such as fertilization, irrigation, or drainage are highly important. If non-agricultural uses are being considered, such things as drainage, accessibility to transportation, stability as a building site, and cost of correcting any adverse conditions must be determined.

Increased mechanization enhances the desirability of relatively large, level fields for agricultural production. The same characteristics favor large scale urban development. Hence, other things being equal, a relatively broad and level flood plain is likely to reach a higher stage of development than one which is narrow and uneven.

It may not be physically or economically feasible for a project to meet all of the potential needs of the watershed. For example, an irrigation project probably will not supply full water requirements 100 percent of the time. Correct evaluation requires that sufficient information be obtained and analyzed to determine the proportion of needs that will be met, the production inputs that will be applied under these conditions, and the production that can be expected.

The intentions of present operators do not necessarily indicate the extent of future enhancement. They are helpful, however, in determining the delay to be expected in reaching the full level of benefits.

In order to claim "restoration of productivity" as a benefit, assurance should be had that (1) the land was formerly used for crop or pasture production, (2) that the change from its former use resulted from flooding and (3) that the reduction in flooding will be effective in permitting restoration to its former use.

The benefit calculation should be based on the effect of the measures in reducing or eliminating the existing restrictions on higher use. For example, determination of the area subject to development after flood protection will involve estimating the area flooded in each evaluation reach with and without the improvement being evaluated. The relationship of flooding to land use will be indicated by the use to which it is now being put under various conditions of flooding. That is, if land flooded one year in three is used for pasture at present, it and similar land likely will be used for pasture in the future if flooded at the same frequency. If, however, the frequency is reduced to one year in five, the land now in pasture may be converted to crops.

Calculations of net returns without and with project should take into account flood damages with the project as well as the cost of conditioning or developing the land for a change in use. The net return with the project is reduced by deducting the additional damage from the remaining floods to the higher values.

In those instances where there is a lag in attaining the maximum benefit, appropriate discounting procedures should be used. For example, when irrigation improvements are installed, farmers probably will need to experiment for a few years to learn amounts and times of water and fertilizer application to get optimum results.

III. CONSTRAINTS IN BENEFITS FROM ALLOTMENT CROPS

Certain crops are under acreage allotments or marketing quotas because otherwise production would be in excess of current or foreseeable needs. Others may be in surplus supply, although not restricted by allotments. Extreme caution should be exercised in claiming benefits from increasing the acreages of these crops as a result of project installation. This applies to all benefits of the enhancement-type described in this chapter.

As the population increases, some increase in the production of these crops will be needed, but much of the increase may result from improved technology. Consequently estimates of acreage increases should be restricted severely and should be assumed to accrue gradually over time. If such increases are evaluated, it should be assumed that they progress uniformly over the evaluation period. The benefits should be discounted accordingly.

Furthermore, if it is assumed that such increases will come about primarily through population pressures or increased world-wide economic well-being, it follows that the major effect of a project may be only to change the location of the acreage increase. For example, project protection may cause the increase in a given area to be wholly in the flood plain instead of in both the flood plain and the upland. Here the credit to the project would be limited to the increase in net returns from acreage only in the flood plain over those obtainable if the acreage increases were distributed over both flood plain and upland.

The foregoing applies to cases where it can be expected that the total acreage of the restricted crop will increase. In many cases the favorable project conditions will encourage only a shift of the crop to the benefited

area without increasing the total acreage in the watershed. Then the increased return in the benefited area may be offset partially by a decline in the return in the area from whence the crop was shifted.

In summary, it is essential that benefits from increased acreages of allotment crops be considered conservatively. It is necessary that only project-induced changes be considered. Only the net effect, after allowance for reduced returns elsewhere in the watershed, can be claimed. Finally, whenever these benefits are claimed, appropriate discounting is required.

All of the pertinent factors should be considered before estimating an increase in allotment crops in the flood plain. Neighboring watersheds where flooding, drainage, or an inadequate water supply is not a problem may indicate the relationship of benefited area to other land use for the allotted crops under consideration.

IV. BENEFITS FROM RESTORATION TO FORMER PRODUCTIVITY

In Evaluation Reach X, with a flood plain area of 1,600 acres, flooding has resulted in a considerable amount of cropland being left idle or converted to lower value use. Analysis of land use and production, through enterprise budgets, gives the data Without Project shown in table 4.1.

Table 4.1
Evaluation Reach X - Without Project (Sample)

Land Use	Acres	Flood-free Yield 1/	Gross Value of Production	Production Cost	Net Return
Corn	100	40 bu.	$5,560	$2,400	$3,160
Cotton	100	300 lbs.	9,000	7,230	1,770
Oats	100	40 bu.	3,280	1,600	1,680
Idle	200	-	-	-	-
Pasture	500	$4	2,000	500	1,500
Woods	500	$1	500	250	250
Misc.	100	-	-	-	-
Total	1,600		20,340	11,980	8,360

1/ As projected over evaluation period.

Analysis of information from schedules and other sources and consideration of the protection afforded by the project indicates the former use of the area shown in table 4.2 will be achieved approximately 5 years after project installation.

Table 4.2

Evaluation Reach X - After Restoration of Former Productivity With Project

Land Use	Acres	Flood-free Yield 1/	Gross Value Of Production	Production Cost	Net Return	Difference in Net Return
Corn	270	40 bu.	$ 15,012	$ 6,480	$ 8,532	$ 5,372
Cotton 2/	150	300 lbs.	13,500	10,845	2,655	885
Oats	150	40 bu.	4,920	2,400	2,520	840
Idle	80	-	-	-	-	-
Pasture	400	$4	1,600	400	1,200	- 300
Woods	450	$1	450	225	225	- 25
Miscellaneous	100	-	-	-	-	-
Total	1,600		$ 35,482	$ 20,350	$ 15,132	$ 6,772

Increased Net Return (Gross Benefit)	$6,772
Less Added Flood Damage to Higher Values	150
Less Development Cost (Associated Cost)	650
Less Loss in Upland Production of Cotton	500
Unadjusted Increased Net Return	5,472
Adjusted for Lag in Accrual (Net Benefit) 3/	5,144

1/ As projected over evaluation period.
2/ Assuming that 50 acres has been transferred from upland to flood plain.
3/ Assuming 100-year evaluation, 3 percent interest, 5-year lag, factor 0.940.

Table 4.2 is designed to illustrate several points in the analysis. (1) Under all conditions there probably will be miscellaneous land, farm roads and the like. In fact, as the intensity of use increases, the area in miscellaneous use may increase because of added needs for roads, build ings and other requirements. (2) When crops are moved from the upland to the flood plain, there is likely to be reduced production and net income in the upland. This should be considered. The $500 that has been deducted from the gross benefit to account for the shift of cotton could have been added to the production cost of cotton. (3) In almost all cases with flood prevention, there will be some added damage. In this case it has been assumed to be one percent of the increase in gross value of production. (4) Shifts in production can be expected to be greater for those uses where the investment, as in land clearing, is less. In this example, the greatest shift was out of idle, followed in order by pasture and woods as the costs progressively increase.

V. EVALUATION OF CHANGED LAND USE FROM LOW TO HIGH AGRICULTURAL USE

The degree of control provided in the assumed case will make it possible for operators to change the use of the benefited area beyond the point where the original use is restored. In table 4.3 it has been assumed that after the 5-year period shown for restoration, farmers have found that it would be profitable to go still farther in cropping the flood plain. Hence they have cleared additional woods and invested heavily in production of alfalfa. They have also replaced part of the native pasture with tame varieties. Some increase in farm roads is shown.

The "difference in net return" column in table 4.3 shows the difference between the "net return" columns of tables 4.3 and 4.2. Costs of establishment of alfalfa and improved pasture are included in the production cost of these crops. These costs have been amortized over the live of the stand at the interest rate the farmers would have to pay. The assumed damage from remaining flooding has been increased to 1.5 percent of the increased gross value of production.

The discount factors used in tables 4.2 and 4.3 were developed in the same manner as is shown in Appendix A, IV, B, except that an evaluation period of 100 years was used. In table 4.3 the build-up period is for 10 years. The period of level annuities is for the last 90 years of the evaluation period and requires discounting for 10 years. Thereby the factor of 0.872 is derived.

In cases where levees, floodways and the like constitute a part of the works of improvement, the lands taken out of production because of these improvements need to be considered in the evaluation. This can be done by showing an increase in the acreage of miscellaneous use with project.

VI. EVALUATION OF BENEFITS FROM MORE INTENSIVE USE OF CROPLAND

In tables 4.2 and 4.3 no increases in yield have been assumed to result from flood protection. In some cases removal of the flood hazard may

Tabel 4.3

Evaluation Reach X - After Land Use Change With Project (Sample)

Land Use	Acres	Flood-Free Yield 1/	Gross Value of Production	Production Cost	Net Return	Difference in Net Return
Corn	300	40 bu.	$ 16,680	$ 7,200	$ 9,480	$ 948
Cotton	150	300 lbs.	13,500	10,845	2,655	0
Oats	100	40 bu.	3,280	1,600	1,680	-840
Alfalfa	300	3 T.	24,570	11,775 2/	12,795	/2,795
Idle	50	-	-	-	-	-
Improved Pasture	200	$20	4,000	2,400 2/	1,600	1,600
Pasture	200	$ 4	800	200	600	-600
Woods	190	$ 1	190	95	95	-130
Misc.	110	-	-	-	-	-
Total	1,600		63,020	34,115	28,905	13,773

Increased Net Return (Gross Benefit)	$13,773
Less Added Flood Damage to Higher Values	410
Less Development Cost (Associated Cost) 3/	1,350
Unadjusted Increased Net Return	$12,013
Adjusted for Lag in Accrual (Net Benefit) 4/	10,476

1/ As projected over evaluation period.
2/ Includes cost of establishment amortized over life of stand.
3/ Includes added taxes and overhead costs.
4/ Assuming 100-year evaluation, 3 percent interest, 10-year lag factor .872.

permit increases in yields merely by allowing farmers to perform operations in a more timely manner. A frequent case is when farmers delay planting in order to avoid spring flooding. Even in flood-free years the yield is reduced below that which would have been expected had they been able to plant at normal times. After they have been given protection, they may reap increased yields by following normal practices.

In other cases, the protection will induce farmers to increase their production inputs markedly. After flood protection, they may develop on-farm drainage systems, fertilize heavily, or perhaps practice supplementary irrigation. Benefits from this source usually are classed as being derived from more intensive use of the benefited land.

This type of benefit is most applicable where drainage or irrigation is involved. Restrictions on bringing new land into production limit the amount of land use change that can be expected. Thus the major share of benefits will be derived from intensification of the use projected under non-project conditions.

Table 4.4 illustrates the evaluation on the assumed Evaluation Reach X, if after reaching the stage of development shown in table 4.3 farmers decided that non-project irrigation would be profitable, and developed and installed irrigation systems.

It is assumed that this development takes place during years 11 through 20 and yields become stabilized after the twentieth year. The damage from remaining floods is assumed to be 2.5 percent of the increase in gross production. A notable factor here is the increase assumed for production costs. For example, the added labor in irrigating, increased cultivation and harvesting costs, and heavier inputs of fertilizer, etc., have increased the production cost of alfalfa from $39.25 per acre (table 4.3) to $88.30.

From tables 4.2 through 4.4 the average annual benefits from restoration of former productivity, changed land use, and more intensive use of land accruing to Evaluation Reach X may be summarized:

1.	Average annual benefit from restoration of former productivity (table 4.2)	$ 5,144
2.	Average annual benefit from changed land use (table 4.3)	10,476
3.	Average annual benefit from more intensive use of agricultural land (table 4.4)	12,543
Total		28,163

Other approaches could be developed. The arrangement presented here illustrates the need to keep the benefits of various types separate to insure that there will be no duplication of benefits. It also shows the

Table 4.4

Evaluation Reach X - After More Intensive Use of Land with Project (Sample)

Land Use	Acres	Flood-free yield 1/	Gross Value of Production	Production Cost	Net Return	Difference in Net Return
Corn - Irrigated	295	70 bu.	$ 28,704	$ 11,800	$ 16,904	$ 7,424
Cotton - Irrigated	145	750 lbs.	32,625	18,342	14,283	11,628
Oats - Dryland	100	40 bu.	3,280	1,600	1,680	0
Alfalfa - Irrigated	295	6 T.	48,321	26,051	22,270	9,475
Idle	50	-	-	-	-	-
Improved Pasture	200	$20	4,000	2,400	1,600	0
Pasture	200	$ 4	800	200	600	0
Woods	190	$ 1	190	95	95	0
Miscellaneous	125 2/	-	-	-	-	-
Total	1,600		$117,920	$ 60,488	$ 57,432	$28,527

Increased Net Return (Gross Benefit)	$28,527
Less Added Damage to Higher Values	1,275
Less Development Cost (Associated Cost) 3/	7,500
Unadjusted Increased Net Return	$19,752
Adjusted for Lag in Accrual (Net Benefit) 4/	$12,543

1/ Eventual yield after full development period.
2/ Allows for area in irrigation and drainage ditches and roads.
3/ Installation amortized over facility life plus operation and maintenance. Includes added taxes and other overhead.
4/ Assuming 100-year evaluation period, 3 percent interest, increase between years 10 and 20, factor .635.

probability that different types of benefits may accrue at different times and therefore will need to be discounted at different rates. Adjustments for development and other associated costs are accounted for.

VII. BENEFITS OF CHANGED USE FROM AGRICULTURAL TO NON-AGRICULTURAL OR MORE INTENSIVE USE OF NON-AGRICULTURAL PROTERTY

As described in Section IB, changed land use is not limited to agricultural use. Sometimes there may be project-induced or project-accelerated changes from agricultural to non-agricultural land as when rural residences are established, or cities expand into agricultural areas. At other times more intensive use is made of urban property as a result of the project.

Evaluation of benefits from such developments requires a careful appraisal of the existing situation, past trends, and future potential. A topographic map of the area under consideration is needed. This should show as a minimum the area that would be flooded by a one percent chance storm without the project and after project installation. Except for low damage use, such as parks, most non-agricultural developments should not be considered within the area flooded after project installation by the once in 100-year flood.

Information which is pertinent to appraisal of an area considered for development includes:

(1) Recent population trends,
(2) Population projections for the general area,
(3) Water supply,
(4) Topography of the area,
(5) Opportunities for new industries,
(6) Relative desirability of other areas for development.

Sources of information on potential non-agricultural development may be:

(1) Urban or county planning boards or commissions,
(2) Real estate associations and developers,
(3) Chambers of Commerce,
(4) Industries in the area,
(5) Retail business associations,
(6) Utility companies.

Frequently most complete and reliable information can be obtained from planning boards when they have made plans for development of an area in which the flood plain is included.

Because of the many variables as to types and rates of development that may take place, a careful analysis of all the information available is required in estimating benefits from non-agricultural land use changes.

If it is decided that development will take place in the protected area, the next determination is whether the project will cause the development, or merely cause a shift of development from another location.

In many cases the latter will be the case.

When there is a project-induced shift to the protected area, the project can be credited only with the advantage of this area over its alternatives. Such advantages may be measured in terms of increased values and reduced costs. In residential developments there are many factors having a bearing on desirability for home sites that usually are not considered subject to normal monetary evaluation. An example is convenience to schools and churches. However, these factors eventually find monetary expression in terms of what the prospective homeowner is willing to pay.

Principles underlying the evaluation of benefits when flood protection permits urban development of a flood plain in lieu of a less desirable alternative area are illustrated in the following example.

Protection given Evaluation Reach Y will permit development of 200 acres of residential use in place of the most favorable alternative of 200 acres of area Z outside the city. No use presently is being made of Y but Z is in agricultural use which is producing a net income of $20 per acre. The cost of bringing utilities to Z and developing streets would be $150,000 greater than to supply these to Y because of soils and terrain, but exclusive of site location. With protection but without development, the raw value on account of location of Y for homesites is $1,000 per acre compared to $500 for Z. Development of either area would occur over a 20-year period. The evaluation might take this form using 3 percent interest, an evaluation period of 100 years and a uniform rate of development over the first 20 years.

Amortized advantage of Y over Z for homesites ($100,000 x 0.03165)	$ 3,165
Amortized advantage of Y over Z in utility development ($150,000 x 0.03165)	4,748
Loss of farm income not incurred in area Z (200 acres x $20)	4,000
Total annual advantage of Y over Z	$11,913

The $3,165 added value for homesites will accrue immediately after protection and will not need to be discounted. The remaining $8,748 will accrue over the development period and will be discounted to $6,587 at 3 percent interest (factor .753). Thus the total benefit will be $9,752.

In this instance it was assumed that there would be no difference in the value of the housing in Y and Z that would not be reflected in land values.

In case there had been no alternative area for development, and protection by the project had permitted the city to grow only by expanding into Evaluation Reach Y, the evaluation would have been concerned only with the area being developed.

The preferred method would have been to have appraised the increase in the capital value of the land after development in comparison with its value in its original state. Next all associated costs of development would have been deducted. The net increase then would be converted to its annual equivalent value.

A less direct method would have been to determine rental values after development. When using net rental values it is realistic to assume something less than 100 percent occupancy. Full allowance should be made for such items as interest on the investment, depreciation, repairs, taxes and the like. The general principles involved are similar to those illustrated under Changed Use of Agricultural land.

VIII. ADJUSTMENTS IN BENEFITS

In nearly all cases of enhancement-type benefits, the final benefit creditable to the project will need to be determined after consideration of such factors as the rate of benefit accrual and the effect of the remaining flooding or other incomplete removal of risks that the project is designed to remove.

A. Adjustments for Lag in Accrual

Enhancement-type benefits seldom can be expected to reach their full value immediately after project installation. Time will be needed to clear land or otherwise get it in physical shape for production after flood protection is provided. Time may be required for recovery from disturbance occasioned by land leveling, and installation of on-farm drainage or irrigation systems.

In addition to the delays caused by these physical factors, there are delays stemming from management and financial limitations. Farmers may not have the capital to take immediate advantage of project facilities. They may need time to discover the best production patterns and the inputs needed for most profitable production. This may be especially true in the case of new irrigation developments where time is needed to learn when to irrigate, how much water to apply, and the response to fertilizer. It often may happen that a farmer is semi-retired and will not expand production during his tenure.

If the time lag between installation and full production is but a year or two, it does not need to be considered. But if it approaches five years or is longer, appropriate discounting is necessary. Several illustrations are shown in this chapter. A more complete discussion together with certain short-cut discount factors appears in Section IV of Appendix A.

B. Adjustments for Remaining Flood Damage to Higher Value Use

When a project permits a shift to higher value use, susceptibility to damage if a flood should occur is increased. Complete flood

protection to agricultural areas seldom is provided. As a result, the remaining floods cause higher damage than if the land were in its original use.

The damage can be calculated by evaluating the effect of the flooding on the new damageable value with project installed. The excess of this damage over that found when the original damageable values were used should be deducted from the gross benefit from enhancement.

This correction is most important when agricultural values are involved. Non-agricultural enhancement ordinarily will not be undertaken unless a high level of protection is provided.

C. Other Adjustments to be Considered

Adjustments of benefits may be needed when projects are developed for irrigation or drainage. In either case, through capital or other limitations, some of the potential beneficiaries may fail to take full advantage of the project facilities. A common failure may be that on-farm installations are not maintained at full efficiency.

A common method of handling this problem is to examine the operation of similar nearby areas where these improvements are in operation. Based on such analyses, the potential benefits from the project are adjusted downward for the expected percentage of participation or the degree of effective maintenance.

A somewhat different adjustment is needed when it is not practicable to provide sufficient water to meet full irrigation needs 100 percent of the time. In this situation it is recommended that the adjustment be made in the crop enterprise budgets by reducing the projected yield below that which could be obtained with a full water supply. In most cases the water supply will be adequate for some of the crops. Farmers can be expected to use available water for those crops where the response is greatest. Therefore, adjustments probably will be needed in the yields of crops which are least responsive to additional water.

Edmonds

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE - P.O. Box 2890
Washington. D.C. 20013

June 15, 1978

ECONOMICS GUIDE

NOTICE NO. 12

Attached are revised pages 1 through 3 to be inserted in Chapter 5, Erosion and Sediment, Economics Guide. The change on page 3 clarifies the determination of future conditions in the project analysis of permanent land damage.

R. M. Davis
Administrator

Attachment

CHAPTER 5

EROSION AND SEDIMENT

This chapter deals with the economic evaluation of land damage by erosion and sedimentation. It describes methods that are suitable for use in estimating the monetary value of damage to the productive capability of land from sediment deposition and erosion. Included also are methods for evaluating sediment damage to irrigation and drainage facilities, reservoir sedimentation and a procedure for estimating intangible environmental losses.

The method selected for evaluation must consider the period of time over which land damage will last. Where permanent damage is occurring or is expected to occur, the method selected must reflect the significance of this permanent loss over time. Where damage is not permanent and partial or full restoration of productivity is physically and economically feasible, monetary values of damage must be adjusted to reflect the degree and rate of recovery. Costs of nonstructural measures needed to achieve the rate and/or degree of recovery are accounted for in determining the damage estimate.

A thorough evaluation of sediment and erosion damage requires an interdisciplinary team. Basic to the team is the economist and geologist. Other members of the team will vary with the type of problems encountered. Contributions from agronomists, soil scientists, biologists, recreationists, engineers, hydrologists, or a variety of disciplines from the environmental field will be required to provide physical data needed for an evaluation.

The economist and geologist have a primary responsibility in seeing that evaluations are made from the appropriate point of view. For example, effects of alternative courses of action will reflect the "without project" and "with project" concept explained in Chapter 1. In addition, the idea of basing the physical and economic evaluation on expected future conditions (Chapter 15) should also be retained by all team members.

I. TYPES OF DAMAGE

A. Erosion Damage

For purposes of this chapter, erosion damages are classified and evaluated under the headings of gully, streambank and streambed incision and flood plain scour. Land may or may not recover from erosion damage. Generally, gully and streambank erosion are considered a permanent or nonrecoverable damage, whereas flood plain scour is generally temporary because partial or complete recovery of productivity is usually physically and economically feasible.

B. Sediment Damage

It is recognized that in some cases sediment is not detrimental. For example, stream hydraulics are affected by sediment content, and muddy water is less erosive than clear water; most fertile flood plains have been developed over a long period of time, as a result of nonaccelerated sediment deposition; algal growth is inhibited by suspended sediment; land derived pollutants, both chemical and bacterial, often attach themselves to soil particles which are amenable to concentration and collection in relatively small areas.

However, the preceding beneficial effects creditable to sediment are usually small and often difficult to quantify in physical or economic terms. Damage by sediment is generally much greater than its benefits.

The most common types of damage by sediment are:

1. Overbank deposition -- Burial of fertile soils by less fertile sediment.

2. Damage to growing crops -- Either by direct damage to the crop or indirectly by disrupting farm irrigation or drainage systems.

3. Swamping -- Impairment of drainage with accompanying rise of water table and an increase in swampy areas of alluvial land.

4. Channel filling -- Aggradation of natural or manmade channels causing more frequent flooding, increased flood heights, and/or interruption of irrigation and drainage systems. Channel filling may also result in changes of the channel course.

5. Reservoir deposition -- Capacity loss in reservoirs. Swamping above delta of reservoir and rise in water tables by impedance of ground-water inflow.

6. Other nonagricultural and agricultural -- Damage to railroads, bridges, roads, powerlines and other facilities. Ditches and road grades may be filled to the extent where regrading is necessary. In urban areas, homes, commercial and industrial buildings and contents are damaged by sediment deposition.

7. Suspended sediment -- Water supplies are often contaminated and made turbid by sediment.

8. Recreational and environmental -- Prolonged periods of excessive turbidity have damaging effects on fish, wildlife and natural vegetation. Even low levels of turbidity reduce esthetic values and may cause abandonment of recreational facilities. For example, people do not like to swim in muddy water. Fine sediment particles can attract, adsorb, concentrate and transport toxic chemicals, radioactive substances and pathogenic bacteria when they are available in the environment. Swampy areas caused by sediment deposition provide breeding and dispersal areas for mosquitoes and other objectionable insects.

9. Deposition in channels, harbors, bays and estuaries -- The filling of channels, bays, estuaries and harbors with sediment interferes with navigation and with marine life breeding areas and habitat.

II. METHODS OF EVALUATING LAND DAMAGE

A. Evaluation of Permanent Land Damage

The following procedure may be used to evaluate erosion or sediment damage where productive capacity is essentially destroyed or where restoration of productivity is not economically feasible. The land use and cropping pattern (crop rotation) used in the analysis should reflect the most probable future condition. This condition should be determined by an interdisciplinary team which includes the District Conservationist.

This approach does not imply that SCS objectives relating to the need for adequate land treatment are being ignored. Realistic projections must be used to recognize realities. Not all acres will ultimately be adequately treated nor will vegetative means of controlling erosion have a high probability of total acceptance by landowners and operators.

Yield estimates used within the study will be those obtained by farmers following a moderately high level fertility and management program. These conditions should also be projected in accordance with Chapter 15 of this guide.

The evaluation of damage will be based upon the annual physical losses as determined by the geologist. Determination of depreciated lands adjacent to and associated with areas voided by gully erosion, streambank erosion and nonrecoverable areas damaged by sediment is the joint responsibility of the geologist and the economist.

The estimate of future damage will recognize the various degrees of depreciation that may occur on lands immediately associated

with nonrecoverable damage areas. For instance, the "fingerlings" or lateral gullies formed from the main gully can establish a pattern which makes it necessary to abandon field cropping but may permit use of the land as pasture, woodland, or for recreation. Where this occurs, these acres are a part of the depreciated (but not fully depreciated) erosion area. It will be the joint responsibility of the geologist and the economist to determine the additional area of land and the degrees of depreciation resulting from the gullying process (Table 5.1).

The net income method is used to evaluate damages. This is accomplished by developing enterprise budgets for each crop and weighting the values to arrive at net income per composite acre. Benefits are the difference in net income from the undamaged or less damaged "with project" condition and the damaged or "without project" condition. In cases where the alternative being evaluated is not expected to be 100 percent effective, assistance from the geologist and engineer is required before completing the economic analysis of "with project" conditions.

In this analysis, the opportunity cost for labor is considered to be insignificant. Thus, the net return computed will be that accruing to land, labor and management. This exception in economic analysis is warranted only where the loss through land voiding and depreciation is small relative to entire farm operation.

An example showing the summation of the analysis follows. This analysis has incorporated physical data provided by the geologist.

Table 5.1 - Annual Damage Rates per Acre by Damage Class and Total Annual Damages

Per Acre			Loss Per Year	
Yield Reduction (percent)	Net Return (dollars)	Reduced Returns (dollars)	Area Damaged (acres)	Reduced Returns (dollars)
0	60.00	0	---	0
70	8.00 1/	52.00	0.50	26.00
90	3.00 2/	57.00	0.75	42.75
100	0	60.00	0.75	45.00
Total	---	---	2.00	113.75

1/ Relegated to a less intensive cropping pattern.
2/ Shifted to low grade pasture.

Post-It™ brand transmittal memo 7671 # of pages ▸ 1
To Larry Eliason Co. Dept. Fax #
From Dave Headley Co. Phone # Fax #

Since the amount of damage is expected annually over the evaluation period without recovery the next step is to adjust the damage to reflect cumulative effects, and then to convert to an average annual equivalent.

Annual Reduction in Net Returns	$113.75
Present value of an increasing annuity @ 5 3/8 percent for 100 1/ years	352.89063
Present value 100 year income stream	$40,141
Amortization 5 3/8 percent interest, 100 years	.05404
Average annual damage	$ 2,169

A more complete explanation of the above method of discounting is found in Appendix A, page 4, problem 2. Problems 3 and 4 of the Appendix are appropriate where damages are not increasing uniformly over the evaluation period.

Additional onsite benefits accrue to landowners where installation of land treatment measures is not feasible without stabilization measures. Unstable outlets for waterways frequently prevent the installation of terrace systems, surface drainage systems and tile drainage systems. In such cases increased net returns that occur on the drainage area of a stabilizing measure over the amount obtained without stabilization are creditable to the alternative being evaluated. Where such benefits are claimed care must be taken to see that cost of the interdependent land treatment measures are deducted as associated cost.

Evaluation of interdependent measures involves an analysis of net income differences resulting from the application of alternative conservation systems. Thus, the level of management is held constant. The net return, therefore, is to land and management.

The following example illustrates an analysis made for 216 acres of land, Capability Class IIIe1, located in the Midwest. Land use and cropping patterns are consistent with recommendations contained in the Work Unit Technical Guide. They represent practical choices by individual landowners.

In this analysis, level of managerial ability is similar in both instances.

1/ Period of time and interest rate should be consistent with those used to reduce project costs to an average annual equivalent.

Table 5.2 - Costs and Returns Without Terraces and Waterways

Crop	Acres	Yield	Gross Income	Production Cost[1]	Net Income
Corn	72	86 bu	$ 6,560	$2,690	$3,870
Alfalfa	144	3.7 ton	9,720	5,800	3,920
Total	216	--	$16,280	$8,490	$7,990

Table 5.3 - Per Acre Costs and Returns With Terraces and Waterways

Crop	Acres	Yield	Gross Income	Production Cost	Net Income
Corn	100	95 bu	$ 9,970	$3,890	$6,080
Alfalfa	100	4.1 ton	7,480	4,310	3,170
Misc.[2]	16	--	--	--	--
Total	216	--	$17,450	$8,200	$9,250

Increased net return (gross benefit)	$1,260
Less associated costs ($6,477 x .08718[3])	
and O & M ($65)	630
Benefits creditable to structural stabilization	$ 630

B. Evaluation of Land Damage Subject to Recovery

Two basic situations are frequently encountered when appraising recoverable land damage. First, areas will be found where new damage is approximately in equilibrium with recovery of productivity on old damage areas. Second, another situation encountered will be where an increase in the area damaged or the severity of the damage is taking place and recovery, due either to natural process or normal farm operations, is also present. In this case the benefits to be derived with a program will consist of reducing the rate of damage so that the equilibrium point will be shifted in the direction of less loss in income.

1/ Includes fixed and variable costs.
2/ Includes waterways and turnrows. In some cases forage produced on the waterway will provide economic returns.
3/ Amortization factor, 6 percent interest over 20 years.

1. Suggested Evaluation Method Where Damage and Recovery are in Equilibrium

Data will be obtained from the geologist and other physical scientists on the total area damaged and the loss in productivity. The economist will then evaluate the annual net loss in income from this damaged area as the present damage.

To illustrate, a flood plain under undamaged conditions has 4,000 acres. Also, on this undamaged land the annual composite gross value of production is $80.00 per acre, with production costs of $45.00 and a net return of $35.00 per acre. An analysis of costs and returns on the area, by percent damage classes, shows the following:

Table 5.4 Composite Per Acre Cost, Returns and Loss on Damaged Land

Yield Reduction (Percent)	Gross Production (Dollars)	Cost of Production 1/ (Dollars)	Net Return (Dollars)	Loss (Dollars)
Undamaged	80.00	45.00	35.00	0
10	65.00	35.00	30.00	5.00
30	50.00	32.00	18.00	17.00
50	37.00	28.00	9.00	26.00
70 2/	22.00	18.00	4.00	31.00
90 3/	7.00	5.50	1.50	33.50

Next, the geologist has appraised the physical damage and provided the economist the data shown in the first two columns in Table 5.5.

1/ Includes fixed and variable costs.
2/ Shifted to lower value crops.
3/ Low grade pasture.

Table 5.5 - Summary of Total Average Annual Damage, Without Project

Percent Damaged	Acres Damaged	Damage Per Acre (Dollars)	Total Damage (Dollars)
10	1200	5.00	6,000
30	600	17.00	10,200
50	300	26.00	7,800
70	60	31.00	1,860
90	10	33.50	335
TOTAL	2170	xx	26,195

The figure $26,195 is the total annual loss in net crop and pasture income from the 2,170 acres affected in the 4,000 acre flood plain because of land damage. If land damage is not expected to fully recover or recovery will extend beyond one year, appropriate corrections in these estimates are necessary.

Where the nonrecoverable portion of the land damage will continue after installation of a program, damage reduction benefits are confined to the recoverable portion. For example, in the 4,000 acre flood plain used in the above example the geologist furnishes the following data.

Table 5.6 - Relation Between Damage, Recovery Time and Damage Remaining After Recovery

Percent Damage	Years to Recover	Percent Damage After Recovery
10	5	0
30	10	10
50	15	30
70	20	50
90	50	70

With the above data given, it is now possible to adjust for the recovery factor in the damage calculation. Using the 50 percent damage class for illustration and going back to Table 5.4, we find a net loss of $26.00 per acre for the 50% damage rate. Table 5.6 shows this area can recover in 15 years to the point where a 30% damage will remain. Table 5.4 also shows the net loss for the 30% damage to be $17.00 per acre. Therefore $26.00 - $17.00 or $9.00 per acre is the value of eventual recovery for the 50% damage.

Assuming a uniform recovery, the straight line discount factor for a 100-year evaluation period for a 15-year lag is 0.710 at 5 3/8%. Then $9.00 x 0.710 = $ 6.39. The other values in the tabulation may be derived in a similar manner. In summary we then have the following:

Table 5.7 - Adjustment to Determine Values Subject to Recovery

Percent Damage	Acres to Recover	Per Acre Value: Undiscounted (dollars)	Per Acre Value: Discounted (dollars)	Total Potential Recovery (dollars)
10	1,200	5.00	4.51	5,412
30	600	12.00	9.58	5,748
50	300	9.00	6.39	1,917
70	60	5.00	3.17	190
90	10	2.50	0.90	9
TOTAL	2,170	xx	xx	13,276

In this example the total annual damage subject to recovery is $13,276.

2. Suggested Evaluation Method Where the Rate of Damage is Increasing and Recovery is Taking Place

This method takes into account the fact that, in most instances, the period over which a given rate of damage can occur is limited by either the area subject to damage, characteristics of the land, or by the maximum decline in productivity and income expected.

The geologist will provide an estimate of the rate at which the damage is progressing, plus an estimate of the eventual limits to the damage in terms of the total area that may be affected.

In addition to the damages shown in Table 5.7, the area being damaged is increasing 20 acres per year and will continue until 200 additional acres have been subjected to damage. By damage classes the annual increase in damage is as follows:

Table 5.8 - Annual Rate of Increasing Damage

Percent Damaged	New Damage Per Year	Damage Per Acre	Annual Rate of Increase
	(Acres)	(Dollars)	(Dollars)
10	10	5.00	50.00
30	5	17.00	85.00
50	5	26.00	130.00
TOTAL	20	xxx	$265.00

For the 10 percent damage category, 10 additional acres are being damaged annually at the rate of $5 per acre, or a total increase of $50 per year. It can be seen that this damage is similar to an increasing annuity. The present value of an annuity increasing by one per year for 10 years is 38.44631 at 5 3/8 percent interest. After 10 years[1] the damage will stop incrasing and will remain constant for the balance of the 100-year evaluation period, or for 90 years. Thus, we have the following:

$50 x 38.44631	= $1,922	(Present value of the damage during first 10 years.)
$500 x 18.43745 2/	= $9,219	(Value, 10 years hence, of damage during last 90 years of evaluation period.)
$9,219 x 0.59241 3/	= $5,461	(Present worth of damage for last 90 years.)

1/ 200 acres ÷ 20 acres = 10 years or the number of years required for 200 acres to be damaged at the assumed rate of 20 acres per year.
2/ Present value of an annuity of 1 per year for 90 years.
3/ Present worth of 1 ten years hence.

The present value of the future loss on the area subject to increased damage is $5,461 + $1,922 = $7,383. The average annual equivalent value thus becomes $7,383 x 0.05404 = $399.

Calculations using the same years and interest and discount factors for the 30 and 50 percent damage categories give average annual damages of $678 and $1,037 respectively.

Thus, the loss due to increasing damage becomes $399 + $678 + $1,037 or $2,114.

A shorter method of arriving at the total would be to use the total annual rate of increase of $265 and follow through the steps shown for the 10 percent category. The actual calculation would be:

$265 x 38.44631 1/ = $10,188

$2,650 x 18.43745 2/ = $48,859

$48,859 x 0.59241 3/ = $28,945

$28,945 + 10,188 = $39,133

$39,133 x 0.5404 4/ = $ 2,114

The above total of $2,114 is the average annual loss on the 200 acres subject to damage and does not account for future production loss on areas already damaged. The next step then would be to combine the production lost in Table 5.7 with the $2,114. This is illustrated in Table 5.9.

The $13,276 of annual recoverable damage, Table 5.7, plus $2,114 of recovery of land subject to increasing damage equals $15,390 preventable damage with a 100 percent effective program.

1/ P. V. of Increasing Annuity for 10 years @ 5 3/8 percent.
2/ P. V. of Annuity of 1 per year for 90 years @ 5 3/8 percent.
3/ P. V. of 1, 10 years hence, @ 5 3/8 percent.
4/ Amortization for 100 years @ 5 3/8 percent.

Table 5.9 - Annual Value of Recoverable Damage

Percent Damage	Recovery on: Area Already Damaged	Recovery on: Area Subject to Increasing Damage	Total
	(dollars)	(dollars)	(dollars)
10	5,412	399	5,811
30	5,748	678	6,426
50	1,917	1,037	2,954
70	190	--	190
90	9	--	9
TOTAL	13,276	2,114	15,390

Where the rate of land damage is increasing, appropriate adjustments must be made in the damageable values, in the estimates of crop and pasture damage from floodwater or in acres subject to damage in order to prevent double counting of damage on the same area. This adjustment can be made in several ways. One approach is to first convert all damage sustained to date (Table 5.5) to equivalent acres of total or 100 percent damage. This can be easily found by multiplying the "acres damaged" column by the "percent damaged" column in Table 5.5 The result is 501 acres.

In terms of productive capacity the 4,000-acre flood plain, because of flooding, is equivalent to 3,499 acres (4,000 - 501). The estimated annual equivalent damage will increase by $2,114 or ($2,114 ÷ $26,195) 8.1 percent of the value of productivity lost on the "area already damaged," Table 5.5. Then 501 x 0.081 = 41 additional acres totally damaged that will be lost during the 100 year evaluation period. Thus an adjustment in floodwater damages is necessary to account for the decreasing base. Since this 41 acre equivalent area will not have a damageable value, no floodwater damage will be claimed. Then 3,499 - 41 = 3,458 acres. By taking the ratio of acre equivalents of undamaged land for "future without a program" (3,458) and "present without a program" (3,499) we get a factor of 0.99. The estimated annual floodwater damage to crops and pasture on the area subject to increasing land damage can be adjusted by applying the above factor (0.99). This adjustment is not necessary for the damage in equilibrium because flood free crop yield should reflect scour and sediment effects in this area (see Chapter 3).

C. Calculation of Effects of Overbank Deposition for Appraising Alternative Plans

Effects of alternative courses of action may be beneficial or detrimental depending upon the extent of modification of flood frequency, susceptibility of land to damage and sediment load carried by the flow. Where the course of action being evaluated modifies the frequency of flooding and, also modifies the sediment load, the effect on flood frequency should be evaluated first.

The following example illustrates a procedure for evaluating the effects of a plan that includes land treatment and floodwater retarding structures. This method may be used to evaluate effects in individual evaluation reaches or the watershed as a whole.

Without project, recoverable damage,

(Table 5.9) ---------- $15,390

Effects of Land Treatment

Reduction in annual acres flooded

1/ 5% x $15,390 = $770

Reduction in sediment yield

1/ 30% x ($15,390 - $770) or $14,620 = $4,686

Total reduction to land treatment = $5,456

Remaining recoverable damag e

$15,390 - $5,456 = $9,934

1/ Hypothetical Data

Effects of Floodwater Retarding Structures

Reduction in annual acres flooding

1/ 50% x $9,934 = $4,967

Reduction in sediment yield

1/ 20% x ($9,934 - $4,967) or $4,967 = $993

Total reduction to structures = $5,960

Remaining recoverable damage

$15,390 - ($5,456 + $5,960)

or $11,416 = $3,974

Summary of Annual Damages and Benefits

Without Project Recoverable Damage	Recoverable Damages After Land Treatment	With Project Recoverable Damage	Benefits To Floodwater Structures
$15,390	$9,934	$3,974	$5,960

A similar analysis can be made for alternative plans that include different types of structural measures or alternative courses of action.

D. Calculations of Effects of Flood Plain Scour for Appraising Alternative Plans

The evaluation of effects of alternatives follow the same basic planning and economic principles set forth in the previous section. However, the following suggested evaluation technique does differ in detail.

The ability of flowing water to scour is related to its depth, energy, gradient, viscosity, boundary roughness, and other factors.

1/ Hypothetical Data

Guidance for the geologist in making flood plain damage surveys is presented in the SCS National Engineering Handbook, Section 3, Sedimentation, Chapter 7, Field Investigations and Surveys. Geologic investigations in individual watersheds will provide a basis for assigning scour ratings by depth of flooding.

In the following example the scour rating assigned to 0 - 1.0 depth of flooding is 0; 1.1 - 3.0 feet has a scour rating of 1, and 3.1 feet and over has a rating of 3.

Recoverable damage is based on Table 5.9 thus assuming the monetary value is due to flood plain scour instead of sediment.

Analysis of the flood series[1/] resulted in the following totals:

Conditions	Total Acres Flooded by Depth			All Depth
	0 - 1.0'	1.1' - 3.0'	3.1 & over	
Without Project	73,500	75,000	16,500	165,000
After Land Treatment	69,500	65,000	13,500	148,000
With Project	27,000	16,500	900	44,400

The following information is the result of multiplying scour ratings by acres flooded by depths, and computing indices using "without project" conditions as the base:

Conditions	Weighted Scour Rating			Total	Index
	0 - 1.0'	1.1' - 3.0'	3.0' & over		
Without Project	0	75,000	49,500	124,500	100
With Land Treatment	0	65,000	40,500	105,500	84.7
With Project	0	16,500	2,700	19,200	15.4

1/ Average annual acres flooded by depth increments may also be used.

Indices may be considered equal to the percent of damage remaining for each condition. Applying these to the damage shown in Table 5.9 provides the following results:

Summary of Annual Damages and Benefits

Without Project Recoverable Damage	Recoverable Damages After Land Treatment	With Project Recoverable Damage	Benefits to Floodwater Retarding Structures
$15,390	$13,035	$2,370	$10,685

III. EVALUATION OF DAMAGE TO IMPROVEMENTS FROM GULLY AND STREAMBANK EROSION

Gully, streambank and streambed erosion often damage nonagricultural property, including highways, bridges, culverts, streets, business, residential and other structures, as well as farm improvements and structures such as buildings, fences, roads, etc. Expenditures made for temporary measures for protection of improvements and facilities from gully and streambank erosion are included in the average annual damage figure. Where it is feasible to relocate buildings and facilities, the damage without the project can be estimated by determining the cost of relocation, including any loss in production of goods or services caused by the relocation. Data developed in accordance to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 will be helpful in determining relocation costs. In the case of expected damage to highways, the cost involved in repairing the initial damage, plus the initial and future bridging costs during the time the gully enlarges to its maximum width and extent, will be used as the basis for evaluating expected damage without a project. Where a significant period is expected to elapse before relocation, repair, or other expenditures brought about by gullying, appropriate discounting procedures should be employed.

The evaluation is based on conditions expected to prevail with and without project. In certain instances gully or streambank erosion can be expected to progress to the point that specific structures, businesses, facilities, or properties will be damaged or destroyed. Where it is not feasible to relocate or where property is irreplaceable, the damage can be considered as equal to the value at the time of loss less salvage value discounted to present value.

Typical calculations of average annual damage expected without the program are shown below.

A. Where Relocation of Property is Feasible

Cost of relocation	$6,000
Years to point where gullying causes relocation	5
Average annual damage $6,000 x 0.76968[1] x 0.05404[2]	$ 250

B. Where it is Not Feasible to Relocate Property

Value of Structure, business and business property, at time of loss less salvage value	$100,000
Years to point where erosion destroys structures, business or property	5
Average annual damage $100,000 x 0.76968[1] x 0.05404[2]	4,159

C. Where Gullying is Expected to Damage a Highway

Costs to repair or replace the highway and bridging costs	$20,000
Years to point where gullying causes expenditures	5
Average annual damage $20,000 x 0.76968[1] x 0.05404[2]	$ 832

IV. EVALUATION OF SEDIMENT DAMAGE TO RAILROADS AND HIGHWAYS

Local governments and railroad companies spend considerable sums for the removal of sediment to maintain transportation services and to protect investments in roads and structures. Most frequently the expenditures are made to remove sediment from road surfaces, road ditches, culvert and bridge openings, and from those drainageways served by bridges and culverts. The removal

1/ Present value of 1, 5 years hence at 5 3/8% interest.
2/ Amortization, 100 years at 5 3/8% interest.

of sediment from bridges and culverts and adjacent drainageways is usually done to protect structures, including road surfaces and roadbeds, from overflow or other types of floodwater damage. The extent of such expenditures may be treated as representing sediment damage to highways and railroads. Occasionally sediment is not removed in sufficient quantities to maintain services or prevent damage. In these cases, the cost of removing sediment necessary to maintain services may be estimated and used in evaluating the average annual damage expected without a project.

Usually the average annual damage can be calculated by obtaining the sum of expenditures for sediment removal over a representative period of years and dividing by the number of years of record. The expenditures for removing sediment from culverts and bridges and drainageways adjacent thereto should be separated from the cost of removing sediment from road ditches or for removing sediment from road surfaces. As to road ditches, often a major source of the material removed is from the road surface and to the extent its replacement is a part of normal road maintenance it should not be evaluated as a sediment damage.

In cases where additional cost is occasioned for the removal of sediment, originating from erosion at sources other than road surfaces, this expense should be estimated and used in the damage evaluation. It is important to learn the source of the sediment being removed. With this obtained from investigation by geologists, it will be possible to estimate the benefits of the project in reducing sediment damage either through erosion control measures, waterflow control measures, or measures for sediment entrapment.

V. EVALUATION OF SEDIMENT DAMAGE TO MUNICIPAL AND INDUSTRIAL WATER SUPPLIES

The sediment content of water used for municipal and industrial purposes may require large expenditures for treating water to make it suitable for those uses to prevent damage to machinery or other water facilities, and to insure good quality of the manufactured product. (Sediment damage evaluation considered here is not concerned with loss of reservoir storage capacity.) In some instances, these effects may be so adverse as to result in less efficient plant location than would otherwise be the case. These costs involve conditions that are difficult to establish with a reasonable degree of acceptance. In most cases records for municipal and industrial water supplies cannot separate the expenditures for sediment removal from those costs associated with removal of other impurities. Those expenditures identified would be the variable costs. Usually the monetary evaluation of sediment damage can be made by obtaining the expenditures made by municipalities or industrial concerns for treatment of water to correct the damaging effects of sediment, or by obtaining estimates of

damage to machinery and the reduction in quality of product. In some instances water is treated to remove the sediment content as well as to correct other conditions affecting the use of water. In such instances only the additional treatment costs made necessary because of sediment should be used in evaluating sediment damage. An illustration of the type of documentation needed for this analysis follows.

Water treatment costs:

Total average annual expenditures	$3,000
Expenditures because of other than sediment content of water	2,500
Annual treatment costs attributable to sediment	$ 500

In appraising the damage to machinery, expenditures for repairs and the reduced life of machinery can be used as the basis for estimating the average annual damage. Where the useful life of machinery or other water supply facilities are impaired, estimates of the value of machinery affected and the expected life of the property with and without sediment damage should be obtained from the owners. This will provide the information necessary to express the damage as the difference in the annual cost with and without damage. Interest rates used in calculating annual cost should reflect the interest paid by the property holders affected.

The following example illustrates the analysis required to arrive at average annual damage.

Machinery repair costs:

Expenditures for repairs due to sediment (average annual)	$4,000

Reduction in useful life of machinery because of sediment:

Useful life without damage	15 years
Useful life with damage	12 years
Cost of replacing machinery	$100,000.00
Salvage value of machinery	10,000.00
Difference	$ 90,000.00

Calculation of average annual damage:

With damage $90,000 x (0.11928)[1]	$10,735.00
Without damage $90,000 x (0.10296)[2]	9,266.00
Difference	$ 1,469.00

In this example annual damage amounts to ($1,469 + $4,000) $5,469.

Losses due to reduction in quality of product can be estimated by obtaining from the manufacturer the increase in market price that could be realized for the product without the adverse effects of the sediment content of water. Any additional costs of processing, distributing, and marketing the higher quality product should be deducted from the increase in value of the product. Sample calculations of average annual damage are presented below.

Improved quality of product:

Gross value of product without sediment damage	$500,000
Gross value of product with sediment damage	450,000
Difference	$ 50,000
Additional cost of processing, distributing, and marketing the higher quality product	$ 15,000
Average annual damage ($50,000 - $15,000)	35,000

VI. EVALUATION OF SEDIMENT DAMAGE TO EXISTING OR NONPROJECT DRAINAGE AND IRRIGATION FACILITIES

The following discussion applies to onfarm and group facilities where operation and maintenance is not included in the cost of operating and maintaining project works of improvement.

A. Drainage

Sediment deposition in open ditches reduces capacity and impairs drainage by submerging tile outlets and obstructing outlets from lateral ditches. This results in a rise in the

1/ Amortization factor, 12 years at 6% interest.
2/ Amortization factor, 15 years at 6% interest.

ground water table and/or prolonged inundation by surface water. In such cases drainage ditches are usually cleaned out periodically to maintain sufficient depth and capacity. Remedial measures that control sediment will lengthen the period between cleanouts resulting in a reduction of maintenance costs. For practical purposes damages with and without the project can be calculated by using the method described under IV for railroads and highways.

Ditch cleanout costs often include expenditures other than sediment removal. In some cases sediment will have to be hauled away from the excavation area and spoil area purchased. Where this occurs care should be taken to see that such costs are included in the damage estimate. In making this analysis only those costs specifically related to sediment removal should be considered.

B. Irrigation

The foregoing discussion of ditch cleanout costs also applies to irrigation ditches or canals. However, estimates of such costs may not fully reflect all damages when sediment deposition causes an interruption in delivery of irrigation water. Even short delays can cause severe damage to crops during certain stages of growth. Season, length of delay and rainfall over the general area at the time of delay are factors to be considered. Generally irrigation canals are interrupted infrequently. Because of this, historical records may not closely resemble existing conditions nor be useful in projecting damages.

The suggested procedure utilizes the monthly net irrigation requirement, monthly storm distribution, storm frequencies and number of days required to restore delivery. The following example shows how this information is used to assess damages:

Specific Conditions:

1. Frequency at which canal loss can be expected - 6%.

2. Number of days required to clean out and restore service - 15 days.

3. Monthly storm distribution (percent of annual):

January	0	April	5	July	17	October	3
February	1	May	22	August	10	November	1
March	3	June	33	Sept.	5	December	0

4. Damageable value:

Land use, yield and gross income for the area served by the canal:

Crop	Land Use %	Yield	Price	Return	Composite Acre Return
Corn silage	10	20 ton	$ 7.00	$140	$14.00
Sugar beets	20	16 "	15.00	240	48.00
Small grain	10	50 bu.	1.10	55	5.50
Pasture	20	8 AUM	4.00	32	6.40
Alfalfa	40	5 ton	20.00	100	40.00
Total					$ 113.90

5. Consumptive use requirements minus effective rainfall by months for the crops of the irrigated area:

Crop[1/]	April	May	June	July	August	September
Corn silage	--	1.52	2.69	4.77	4.65	1.54
Sugar beets	2.00	2.44	1.99	4.01	3.95	2.57
Small grain	--	2.73	2.34	2.20	---	--
Pasture	2.20	2.73	2.34	4.39	4.30	2.82
Alfalfa	2.41	3.03	2.69	4.77	4.65	3.07

Composite acre water requirement:

Crop	Land Use %	April	May	June	July	Aug.	Sept.	
Corn silage	10		.15	.27	.48	.47	.15	
Sugar beets	20	.40	.49	.40	.80	.79	.51	
Small grain	10		.27	.23	.22			
Pasture	20	.44	.55	.47	.87	.86	.56	
Alfalfa	40	.96	1.21	1.08	1.91	1.86	1.23	
Total	100	1.80	2.67	2.45	4.28	3.98	2.45	17.63

Value added per inch of irrigation water supplied -
113.90 ÷ 17.63 = $6.46

1/ Growing season: Alfalfa - April through September
Pasture - April through September
Sugar beets - April through September
Corn silage - May 15 to September 15
Small grain - May to July 15

Value added per month -

April	May	June	July	August	Sept.	Total
$11.63	$17.25	$15.83	$27.65	$25.71	$15.83	$113.90

Value added per day -

April	May	June	July	August	Sept.
.39	.56	.53	.89	.83	.53

Damage per composite acre from a 15-day break -

April	May	June	July	August	Sept.
5.85	8.40	7.95	13.35	12.45	7.95

Weighted damage per composite acre -

Month	Damage		Monthly Storm Distribution		
April	5.85	x	5	=	0.29
May	8.40	x	22	=	1.85
June	7.95	x	33	=	2.62
July	13.35	x	17	=	2.27
August	12.45	x	10	=	1.25
September	7.95	x	5	=	.40
Total					$8.68

This $8.68 is the weighted damage per composite acre per failure. The average annual damage from delay in water delivery is equal to number of acres served times damage per acre times the storm frequency required to cause the canal to fail. (This assumes that the breaks from more infrequent storms do not require longer to repair.)

If, in the above example this canal serves 1,500 acres, the average annual damages would then be:

1,500 acres x $8.68 x 6% = $781.20

Sediment deposition and/or erosion may also adversely affect the operation of certain types of field application systems. This usually occurs when field gradients or field ditches are damaged to the extent that irrigation water cannot be applied. Analysis of losses resulting from lack of water may be evaluated in the same manner as described on the foregoing pages. In addition, costs of restoring field gradients and ditches should be counted as a damage.

VII. EVALUATION OF RESERVOIR SEDIMENTATION

A. Evaluation Methods

Damages to reservoirs (and benefits) may be estimated by different methods, depending upon (1) the amount of information that is available or that can be obtained within the limitations of budget and other resources, (2) the number of reservoirs to be evaluated, and (3) the importance of the monetary benefits accruing from reduced rates of reservoir sedimentation in relation to the overall economic justification of a water resource project. The four most common methods used are referred to as (1) straight-line, (2) sinking fund, (3) sinking fund plus service loss, and (4) cost of sediment removal.

1. Straight line

The average annual damage is estimated as the product of the average annual rate of sediment deposition in the reservoir, in acre-feet, and the original cost of storage per acre-foot adjusted to the appropriate price base. The average annual benefit is the difference between the average annual damage with and without the project.

a. Total installation cost of reservoir - $1,200,000.00

b. Total reservoir capacity 200,000 acre-feet

c. Cost per acre-foot of storage ($1,200,000 ÷ 200,000) - $60.00

d.	Volume of sediment deposited annually without the recommended project -	335 ac. ft.
e.	Volume of sediment deposited annually with the recommended project -	168 ac. ft.
f.	Average annual damage without project (335 x $60) -	$20,100
g.	Average annual damage with project (168 x $60) -	$10,080
h.	Average annual benefit (d - e) -	$10,020

2. Sinking Fund

The average annual damage is estimated as the annual payment into a sinking fund which at a given rate of interest (current rate for discounting federally financed projects

or current rate available to nonfederal entities where no federal assistance is provided) will accumulate to an amount sufficient to replace at the point of use the supply of water displaced by sediment at the time when the useful life of a reservoir is terminated. The average annual benefit is the difference between the average annual damages with and without the alternative being evaluated.

Example:

a.	Useful life of reservoir without program	- 75 years
b.	Useful life of reservoir with program	- 100 years
c.	Replacement cost of water supply	- $1,000,000
d.	Annual payment without recommended program ($1,000,000 x .00108 1/)	- $1,080
e.	Annual payment with recommended program ($1,000,000 x .00029 2/)	- $ 290
f.	Annual benefit d - e	- $ 790

3. Sinking Fund Plus Service Loss

The average annual damage is estimated as the annual payment into a sinking fund which, at a given rate of interest, will accumulate to an amount sufficient to replace at the point of use the water supply storage displaced by sediment at the time when the useful life of a reservoir is terminated, plus the present average annual worth of all service losses that occur prior to replacement of the reservoir. The average annual benefit is the difference between the average annual damages with and without the recommended program.

Example:

a.	Useful life of reservoir without program	- 75 years
b.	Useful life of reservoir with program	- 100 years
c.	Replacement cost of water supply	- $1,000,000

1/ Sinking fund factor for 75 years at 5 3/8 percent interest.
2/ Sinking fund factor for 100 years at 5 3/8 percent interest.

Note: For derivation of sinking fund factor see Appendix A, page 2, item D.

d.	Annual payment into sinking fund for replacement in 75 years	- $ 1,080
e.	Annual payment into sinking fund for replacement in 100 years	- $ 290
f.	Annual increment of service loss without program	- $ 2,000
g.	Annual increment of service loss with program	- $ 1,000
h.	Present value of service loss 75 years hence without program ($2,000 x 330.04685 1/)	- $ 660,094
i.	Present value of service loss 100 years hence with program (1,000 x 352.89063 2/)	- $ 352,891
j.	Annual equivalent value of services lost without project ($660,094 x 0.05483 3/)	- $ 36,193
k.	Annual equivalent value of services lost with project ($352,891 x 0.05404 4/)	- $ 19,070
l.	Average annual damage without program d + j	- $ 37,273
m.	Average annual damage with program e + k	- $ 19,360
n.	Average annual benefit l - m	- $ 17,913

This example has been simplified for purposes of illustration. Thus, it has been assumed that service losses would begin immediately and would increase uniformly until an assumed date of replacement. In actual practice it will be necessary to determine the time at which loss in service will begin, the rate that such losses will occur, and the point in time when the displaced water supply will be replaced.

1/ Present value of an increasing annuity for 75 years at 5 3/8 percent interest.
2/ Present value of an increasing annuity for 100 years at 5 3/8 percent interest.
3/ Amortization for 75 years, 5 3/8 percent interest.
4/ Amortization for 100 years, 5 3/8 percent interest.

4. Cost of Sediment Removal

The average annual damage is estimated as the product of the number of cubic yards to be removed annually and the cost per cubic yard for removal including land rights cost for disposal areas. The average annual benefit is the difference between the average annual damages with and without the alternative being evaluated.

Example:

a. Volume of sediment to be removed annually without a program - 540,000 cu. yds.

b. Volume of sediment to be removed annually with a program - 270,000 cu. yds.

c. Cost of removal per cubic yard - $1.00

d. Average annual damage without program - $540,000

e. Average annual damage with program - $270,000

f. Average annual benefit (d - e) - $270,000

Where removal occurs several years apart all future costs should be discounted to present worth and amortized over the life of the project.

VIII. EVALUATION OF SEDIMENT DAMAGES TO THE ENVIRONMENT

Society has now made it clear that environmental effects including environmental values ranging from maintaining natural beauty, insuring esthetic quality, protecting the balance of nature, proper handling of solid wastes, disposing of dredged sediment in an environmentally acceptable manner, and controlling water, air, and noise pollution must be evaluated when planning land and water resource development projects. Since these environmental commodities are not usually traded in the market place, the conventional demand-supply-price function does not provide a basis for translating these social preferences into monetary terms. Methods of expressing such effects in terms commonly understood and valued by decision makers are currently being studied and debated.

During the interim, water and land resource planning continues, thus requiring the inter-discipline team to investigate and develop methods that will, to some degree, provide a basis for demonstrating project desirability. Therefore, expected environmental effects of land and water resource development plans should

include a detailed description of physical effects on man's surroundings, social values and economic values measured by simulating a market price.

Sediment, in terms of volume, is often referred to as the "world's greatest pollutant." Literature on sediment damage to the environment frequently refers to the ability of sediment to transport nutrients which accelerate eutrophication of water bodies, cover fish spawning beds and food supplies, destroy esthetic qualities of streams and adversely affect wildlife habitat and nesting grounds. Sediment also can degrade the quality of recreation experience, cause vector problems and carry toxic chemicals, radioactive substances and pathogenic bacteria which may be detrimental to human health.

Since a reduction in sediment yield is brought about by most land and water resource development plans prepared by the Soil Conservation Service, these plans should claim credit for any reduction in damages similar to those described above.

Evaluation of environmental effects requires close coordination between economists, geologists, biologists and other disciplines which may or may not be employed by the Service. Since change in the economy usually occurs simultaneously with or is preceded by physical change, these estimates are a prerequisite to economic evaluation. Physical environmental effects must be quantified in terms of relevant physical and ecological dimensions and described in appropriate qualitative terms before the economist can assess monetary values.

The existence of value has clearly been demonstrated by society's concern for the protection, preservation and enhancement of environmental resources. Consequently the demand for the type of human satisfaction received from such resources is sufficient basis for conferring economic benefit. This seems supported by evidence of willingness to pay by individuals and by all levels of government.

The estimation of economic values should not be limited to one particular approach. A wide variety of pricing methods should be examined in appraising the magnitude of such losses. Where identification and measurement of willingness to pay is not possible, total value to the user may be approximated by taking the lowest cost means of preventing physical damage as a measure of damage to environmental resources. A "with" and "without" project appraisal will recognize the beneficial effects of preventing erosion and effects of concentrating sediment and land derived pollutants in relatively small areas rather than allowing these to be spread throughout downstream reaches. Since this method does not allow for a surplus of benefits over costs, the results may be conservative.

An example of this method of appraisal follows. In the example it is assumed that a floodwater retarding structure controls sediment that otherwise would be transported downstream from the watershed.

1.	Total installation cost	- $250,000
2.	Total storage capacity including sediment pool, acre-feet	- 5000
3.	Cost per acre-foot of storage ($250,000 + 5,000 ac. ft.)	- $ 50.00
4.	Annual sediment yield leaving the watershed, without project, acre-feet	- 1,000
5.	Annual damage without project ($50 x 1,000 ac. ft.)	- $ 50,000
6.	Annual sediment yield leaving the watershed with land treatment, acre-feet	- 600
7.	Annual damage with land treatment ($50 x 600 ac. ft.)	- $ 30,000
8.	Annual sediment yield leaving the watershed with land treatment and structural measures, ac. ft.	- 590
9.	Annual damage with land treatment and structural measures	- $ 29,500
10.	Benefits to land treatment ($50,000 - $30,000)	- $ 20,000
11.	Benefits to structural measures ($30,000 - $29,500)	- $ 500

In this example total yield leaving the watershed was used for computing damages. In many cases the use of this total will cause an overestimate of damages. In some areas that portion of sediment considered damaging may be confined to that produced by accelerated erosion.

For measures not involving storage capacity such as drop spillways, streambank erosion, control structures, etc., the amount used in Step 2 may be considered to be the volume eliminated by the improvement being evaluated. The following example shows the steps for analyzing structural measures that do not have storage characteristics. All figures used in these examples are hypothetical.

1.	Total installation cost	- $50,000
2.	Total volume of sediment reduced at the site, acre-feet	- 250
3.	Cost per acre-foot ($50,000 ÷ 250)	- $ 200
4.	Annual sediment yield leaving the watershed, without project, acre-feet	- 30
5.	Annual damage without project ($200 x 30)	- $ 6,000
6.	Annual sediment yield leaving the watershed with land treatment, acre-feet	- 20
7.	Annual damage with land treatment ($200 x 20)	- $ 4,000
8.	Annual sediment yield leaving the watershed with land treatment and structural measures, acre-feet	- 15
9.	Annual damage with project ($200 x 15)	- $ 3,000
10.	Annual benefits to land treatment ($6,000 - $4,000)	- $ 2,000
11.	Annual benefits to structural measures ($4,000 - $3,000)	- $ 1,000

The foregoing methods of evaluating sediment damage to the environment should be used only in the absence of values more closely related to actual market conditions. Since the residual in this technique is credited to the structural measures, the sediment yield reductions and benefits claimed for land treatment should be checked to determine that their magnitude is consistent with the land treatment proposed in the work plan. These techniques are not intended as a substitute for methods of evaluating sediment damages described in other sections of this Chapter.

Lemon
5/24/'73

New example for Chapt 5
Econ Guide,

Sediment And Erosion

1. Damage is either permanent or recoverable to some degree. The evaluation should reflect this difference.

2. Erosion – Erosion occurs as gullies, streambank erosion or flood plain scour. Gullies and streambank erosion are considered as permanent damage. Flood plain scour is generally temporary as partial recovery is usually physically and economically feasible.

3. Sediment – Occurs as several types of damages – overbank deposition, damage to growing crops, swamping, channel filling, reservoir deposition, navigable channels and harbors, roads and road ditches, fish & wildlife, estuaries, etc.

4. Evaluation of Permanent Land Damage
   a. Need to reflect future loss of net returns in average annual dollars.
      1). Loss of net returns X average annual acres lost.
   b. Benefits will equal the difference in net income from the undamaged or with project condition and the damaged or "without project" condition.

Per Acre Damage Rates and Total Annual Damages

Yield Reduction (percent)	Net Return (dollars)	Damage (dollars)	Av. An. Acres Damaged (acres)	Total Damages (dollars)
0	$60.00	0	—	0
70 [1]	8.00	$52.00	0.50	$26.00
90 [2]	3.00	57.00	0.75	42.75
100	0	60.00	0.75	45.00
Total	—	—	2.00	$113.75

Income loss per year	$113.75
Present value of an increasing annuity @ 5 3/8 percent for 100 years	352.89063
Present value 100 years hence	40,141
Amortization @ 5 3/8 %, 100 years	0.05404
Present average annual damage	$2,169

1] Relegated to a less intensive cropping pattern
2] Shifted to low grade pasture

5. Evaluation of Land Damage Subject to Equilibrium or Recovery (where new damage is approximately in equilibrium with recovery of productivity on old damage areas)

Composite Per Acre Cost, Returns and Loss on Damaged Land

Yield Reduction (Percent)	Gross Production (Dollars)	Cost of Production [1] (Dollars)	Net Returns (Dollars)	Loss (Dollars)
Undamaged	$80.00	$45.00	$35.00	0
10	65.00	35.00	30.00	$5.00
30	50.00	32.00	18.00	17.00
50	37.00	28.00	9.00	26.00
70 [2]	22.00	18.00	4.00	31.00
90 [3]	7.00	5.50	1.50	33.50

1/ Includes fixed and variable costs

2/ shifted to lower value crop

3/ Low grade pasture

Summary of Total Average Annual Damage Without Project

Percent Damage	Acres Damaged	Damage Per Acre (Dollars)	Total Damage (Dollars)
10	1200	$5.00	$6,000
30	600	17.00	10,200
50	300	26.00	7,800
70	60	31.00	1,860
90	10	33.50	335
TOTAL	2170	XX	$26,195

Per Acre Damage Rate, Recovery Rate and Percent Recovery

Percent Damage	Years to Recovery	Percent Damage After Recovery
10	5	0
30	10	10
50	15	30
70	20	50
90	50	70

Using the 50% damage factor as an example the evaluation is:

Net returns @ 30% = $18.00
Net returns @ 50% = 9.00
Increase in net returns = $9.00

straight line discount factor for a 100-year evaluation period for a 15-year bg is 0.710 @ 5⅜%

$9.00 X 0.710 = $6.39 X 300 acres = $1,917

6. Rate of Damage is Increasing and Recovery is Taking Place

Present Damage		Future W/O [1]		Future With	
% damage	acres	% damage	acres	Years to Recover	% damage after recovery
10	1200	10	1400	5	0
30	600	30	900	10	10
50	300	50	400	15	30
70	60	70	80	20	50
90	10	90	20	50	70
	2170		2800		

1) It is estimated by the geologist that without the project, overgrazing deposition will continue to occur and estimated conditions 50 years hence would be 10 acres now at 70% yield reduction would further decline to 90% loss; 30 acres now at 50% yield reduction would decline to 70%; 130 acres at 30% would decline to 50%; 430 acres at 10% would decline to 30%; and an additional 630 acres would have its productive level lowered from 0% yield reduction to 10%. Production level would then remain constant. It is estimated that the project will prevent this further decline in productivity and will enable production to be partially restored through normal production practices.

Using the 50% damage factor as an example the evaluation becomes:

Without the project 130 acres at 30% yield reduction would decline to 50% in 50 years

net returns @ 30% = $18.00
net returns @ 50% = 9.00
Loss in net returns
over 50 years $9.00

130 acres x $9 = $1170 lost over 50 years

$\frac{\$1170}{50 \text{ yrs}}$ = $23.40 annual rate of loss

This damage is similiar to an increasing annuity

Income loss per year	$23.40
Present value of an increasing annuity @ 5 3/8 percent for 50 years	270.24888
Present value	$6,324
Loss from 50th year thru 100th yr	$1170
Present value of an annuity of 1 per year for 50 years	17.24714
Present value 50 years hence =	$20,179
Present value of 1 50 years hence =	.07297
Present value =	$1472
Sum of present values =	$7796

Sum of present values	=	$7796
Amortization factor, 5 3/8% for 100 yrs =		.05404
Present average annual damage	=	$421

The $421 would be in addition to the $1917 from previous example.

DRAINAGE EVALUATION

Donald W. Manley, Agricultural Economist
Soil Conservation Service
Midwest Technical Service Center
Engineering and Watershed Planning Unit
Lincoln, Nebraska

With rare exceptions, we have few projects in which the problem is strictly inadequate drainage. The concern is primarily one of water management which involves both flooding and impaired drainage. Formulation and evaluation, therefore, are related principally to alleviating surface and/or subsurface water problems--regardless of how we attempt to categorize these effects.

Benefits from improved drainage, as measured in increased net returns, have been from increased output, improved efficiency, and in some instances improved quality of products produced.

Added emphasis has been given to identifying that portion of total net benefits accruing from efficiency since OBERS projections have been used as a yardstick for projecting needs for increased output of food and fiber.

The broad goal of most drainage projects has been to provide "adequate drainage" for nondrained or partially drained conditions. Design of the drainage system is often based on drainage coefficients which are used to design structural systems to remove excess surface

and subsurface waters in 24 hours. These coefficients may vary by location, land use, soils and crops. Observation over many years has shown these have provided an economical degree of drainage protection for various crops. Questions have been raised, however, whether net returns have been maximized, even though the system designed shows economic feasibility.

Those that have been involved in drainage projects realize there are many different drainage situations not only in the type and magnitude of the problem, but also in solutions that may be applicable to alleviate the problem.

I would like to discuss with you an overview of three situations we have encountered and procedures used in an attempt to formulate alternative plans that would provide maximum net returns from water management systems. These are as follows:

1. A high water table exists in the spring that restricts timely spring operations, but generally during the growing season the water table recedes to a level that depresses crop yields.

2. Flatland watersheds where conventional flood routings have severe limitations. Surface water caused by abnormally high precipitation and subsurface water restricts planting in a timely manner and damages growing crops.

Due to slow removal of surface water and restricted outlets for subsurface water, gravity outlets are available.

3. The third situation involves surface and subsurface drainage impairment on flooded areas plus subsurface drainage restrictions on areas at elevations above the flooded areas. Pumping is required.

The first situation involves constructing an open ditch that will lower the water table sufficiently to permit timely field operations in the spring.

The water table is then controlled during the growing season by means of control structures in the drain provided with crest boards. These can be used to maintain the upstream water levels during dry periods in connection with a series of side lateral ditches. This type of system is applicable primarily on soils that permit rapid lateral flow. Maumee fine sandy loam is ideal.

Of course, one requirement in addition to soils is an adequate supply of water during the dry seasons. This source is from subsurface flows and surface flows from rainfall. In addition, supplemental water is available to pump into the ditches either from wells or the Kankakee River.

Economic evaluations will be based on increased yields by timely operations plus alternative number of control structures and lateral ditch spacing that will benefit various land areas. Incremental benefits versus incremental costs, including supplemental water source will be as the basis of determining the system that most nearly maximizes the net benefits.

There has not been a great deal of research on these projects; however, Purdue University has done some experimental work. The following is an excerpt from Purdue's findings for a 4-year period.

	Distance from supply ditch-Feet along corn row		
Year	200	400	1600
1959	147	123	115
1960	132	130	125
1961	125	126	126
1962	144	137	128

Evaluation for the second type of area (flatlands) have been based on a procedure, for better terminology abnormal excess precipitation method of analysis.

In brief, damages from surface water are based on floodfree yields under future without-project drainage conditions. Damages per acre foot of surface water are computed based on average depths and weighted for seasonal distribution. The hydrologist provides

acre feet by frequency plus the volume of water remaining after 24 hours which is assumed to be damaging.

EXAMPLE: Future W/O Project

Freq.	Ac'	Ac' Removed	Damaging Ac'	Damages Per Ac'	Dollar Damage
50	1350	150	1200	128.18	153,816
25	1125	150	975	128.18	124,975
10	900	150	750	128.18	96,135
5	610	150	460	128.18	58,963
2	360	150	210	128.18	26,918
.1	243	150	83	128.18	10,638
.5	180	150	30	128.18	3,845

Alternate size channels are evaluated to compute incremental costs versus incremental benefits. Benefits from providing subsurface drainage is added to arrive at total benefits for system.

Summary

Channel Size	Benefits	Drainage	Total
360 Ac'	26,640	25,000	51,640
610 Ac'	38,000	25,000	63,000
900 Ac'	43,280	25,000	68,280

Incremental Costs-Benefits

Alt.	Total Costs	Incremental Costs	Total Benefits	Incremental Benefits
1	28,300		51,640	
		11,000		11,360
*2	39,300		63,000	
		5,400		5,280
3	44,700		68,280	

*Maximized net benefits

The third example illustrates a procedure developed in Michigan with modifications and revisions by Richard Patronsky, Water Management Engineer, EWPU, Lincoln, Nebraska.

The procedure will do:

1. Evaluate on a frequency basin
2. Evaluate both surface and subsurface drainage
3. Consider duration of drainage impairment
4. Consider depth of drainage impairment
5. Evaluate any outlet capacity
6. Can be used for gravity drainage conditions as well as pumps
7. Is adaptable to any topography in the benefiting area.

In general, the procedure considers the following--both future without-project and various alternatives:

1. Acres flooded by depth increments by frequency
2. Impaired drainage - this includes both the area flooded plus 3' above the flooded area in which subsurface outlets are blocked for more than 3 days. The area that has a blocked outlet for 21 days or more is assumed to be similar to an area that has no subsurface drainage.

Example

It is determined, based on stage-area-frequency evaluations, the per acre damages from flooding are $22.57 per cultivated acre.

Impaired drainage reduced net income by $.825 per day of impairment. This was computed as $14.85 per acre net return loss from areas not having subsurface outlets. (14.85 ÷ 18 days = .825)

The following table shows a summary of various pumping rates as they apply to area flooded and area of impaired drainage, and following this table is a summary of incremental costs and incremental benefits from alternative pumping systems.

Average annual damages and benefits for various pumping rates

Pumping Rate Inches/ Day	Area Flooded: Average Annual Area Flooded Cult A	Area Flooded: Average Annual Area Benefited Cult A	Area Flooded: Damages @ 22.57 Per Cult A Dollars	Area Flooded: Benefits Per Cult A Dollars	Area With Impaired Drainage: Average Annual Damages Dollars	Area With Impaired Drainage: Average Annual Benefits Dollars	Area With Impaired Drainage: Weighted Average Annual Benefits 1/ Dollars
0	1290	0	29,115	0	30,600	0	0
0.1	875	415	2/	2/	2/	2/	2/
0.2	570	720	2/	2/	2/	2/	2/
0.3	285	1005	6,432	22,683	4,444	26,156	18,126
0.4	70	1220	1,580	27,535	1,906	28,694	19,885
0.5	0	1290	0	29,115	704	29,896	20,718
0.6	0	1290	0	29,115	200	30,400	21,067

1/ Weighted by 63.9 percent of excessive storms which occur during the growing season (April through November).

2/ Not evaluated because pumping rates less than 0.3 inch per day are usually considered inadequate.

Pumping Rate Inches/Day	Total Av. Annual Benefits	Incremental Benefits	Av. Annual Costs	Incremental Costs
0	0		0	
		40,809		20,915
.3	40,809		20,915	
		6,611		2,536
.4	47,420		23,451	
		2,000		1,113
* .5	49,833		24,564	
		349		5,036
.6	50,182		29,600	

* Optimized pumping rate

In conclusion, the above discussion is not to imply the last word in linking physical theories of land drainage to economic benefits derived has been accomplished. Hopefully it will stimulate some thoughts and above all to point out the need for serious consideration in developing methodologies for improving the translation of drainage requirements into operable criteria for design and economic evaluation.

CHAPTER 6

DRAINAGE MEASURES

Drainage measures produce benefits that consists primarily of increases in annual agricultural income resulting from the increased production of agricultural commodities or reduced cost of production. Drainage benefits are largely on-site and may include the following: (1) Increases in agricultural income with the project less any costs associated with the increase, and (2) other benefits, not evaluated in monetary terms, such as, improvements in wildlife habitat and production and (3) reduction in health hazards.

I. BASIC DATA

The following data is necessary to measure the physical and monetary benefits of drainage measures.

A. Soils

Soil information should be collected and summarized for the area requiring drainage. Soils should be grouped by capability classes, subclasses, or by soil mapping units, whichever is most applicable.

B. Land Use and Crop Yields

Determine by interviews and/or field inspections present land use and crop yields and anticipated land use and crop yields (both with and without drainage). At the same time, information needed for the development of budget analyses for the "with" and "without" drainage conditions should be obtained from farm owners and operators. Such field information should be supplemented by and checked against reports from like areas where drainage improvements have been installed and from other secondary sources.

Information on present and anticipated land use and crop yields for each major soil grouping will provide basic data needed to determine the relative economic advantage of various alternative drainage plans and/or incremental degrees of drainage. Aerial photographs of size and detail adequate to record soil groupings, land use, crops and yield data are useful in delineating sub-areas and establishing evaluation procedures. Where a sampling process has been followed, aerial photographs are excellent to establish validity of the sample and degree of expansion to cover the problem area.

Land use and yields may be restricted by the relative elevation of the water table. Therefore, in estimating future use and yields with the project, consideration should be given to level of control provided by the drainage measures. This may necessitate separate evaluation subareas.

In estimating future yields under non-project conditions, assume the application of on-farm drainage measures and adoption of technological improvements that can reasonably be expected in the absence of the project.

Estimates of future yields with the project should consider the application of land treatment measures necessary to meet the need for drainage. The estimate also should include the effects of technological improvements that can reasonably be expected with the project.

The same period of time should be used for estimates of both future conditions.

C. Production Data

Benefits to drainage measures from increased production are expressed as an increase in agricultural income resulting from the project less any crop production costs and on-farm capital costs associated with the increase. Therefore, estimates of future land use and yields that can be achieved "with" and "without" project conditions must be converted to terms of agricultural income.

With drainage, it is reasonable to expect a wide divergence in cropping patterns that may require considerable changes in production costs. These changes can best be measured by the use of partial or complete budget analyses.

II. BENEFITS

A. Source

Benefits to drainage measures are similar to those from changed land use and more intensive use of flood plain land. That is, benefits occur as an increased agricultural income "with" the project as compared to "without" the project. These benefits are on-site and may include the following:

1. Land Use Changes

With drainage, it may be feasible to cultivate land that has never been cultivated in the past. Wooded land may be cleared and converted to crop or pasture. Pastures or wild land may be plowed and used for crop production. In these conversions, consideration should be given to soils, topography, and the remaining elevation of the water table. Any costs involved in the clearing or preparation of the ground for the changed use should be deducted from the benefits as an associated cost. Policy limitations may limit the extent of benefits claimed from "new land" developments.

2. More Intensive Use

A second source of benefit arises from the opportunity to use

land more intensively. For example, better yields on land in its present use may be achieved as a result of reduced wetness and the opportunity to profit from better rotations and increased use of fertilizer. In addition, the quality of the product may be improved.

3. Reduced Production Costs

Another common source of benefit is through reduction in the cost of tillage operations. Better soil conditions may permit the use of a smaller tractor or reduce the time required to cover an acre. Chances of machinery getting stuck are lessened. The necessity for replanting may be eliminated.

4. Improved Resource Allocation

Benefit may also arise from a re-allocation of the resources used in production. Farmers previously with "wet" and "non-wet" areas in their units may now find it profitable to shift crops between the areas. With the new resource base afforded by the project, changes may be made in types of farming. To measure the effects of these changes on the agricultural income of the area it may be necessary to budget the "before" and "after" conditions on lands outside of the problem area or develop an overall farm or ranch analysis which will incorporate these effects.

B. Evaluation

1. Agricultural income with and without project conditions

From the basic data collected on future land use and yields and on production costs, budgets should be developed to determine the agricultural income "with" and "without" the project. Circumstances that exist in and surrounding the problem area will dictate the method of budgetary analysis to be used. These may include the following analyses: (1) individual crop budgets for the problem area and other lands associated therewith; or (2) an overall farm analysis. In isolated mountain basins or other areas where normal market opportunities do not prevail for the crops produced the analysis may include any associated livestock enterprise.

The increased agricultural income with the project less any associated costs (on-farm capital expenditures or other costs) not covered in the budgetary analysis is a benefit to the drainage measures.

2. Allowance for Lag in Accrual

As with all other types of enhancement benefits, benefits should be discounted for any expected lag in accrual. In some watersheds the operators may have to install on-farm measures (ditches, clearings, etc.) in order to realize the full benefits. The operators may not be able to install all of these on-farm measures during the project installation period even though technical assistance is available. Where this is the case,

appropriate discounting of benefits to reflect the expected lag is required. Where the area to be benefited is now in agricultural production, and most of the on-farm drainage is installed, benefits will usually accrue at their full level within the first year or two after installation of needed measures. In this case, no discounting is required.

3. Division of Benefits Between Drainage and Flood Prevention

In many cases, multiple purpose channels that provide for both drainage and flood prevention will need to be evaluated. In these situations, drainage and flood prevention benefits may accrue on the same areas. The method of evaluation depends upon the type of flood prevention benefits. If the flood prevention benefits are of the enhancement type, the total evaluation can be made by the same method as indicated in this chapter.

If the flood prevention benefits are of the damage reduction type the evaluation should follow methods presented in Chapter 3 for the flood prevention benefits and the methods in this chapter for the drainage benefits.

It is generally accepted that enhancement type benefits resulting from both drainage and flood prevention measures are not identifiably separable. For project analysis an arbitrary division of 50 percent to flood prevention and 50 percent to drainage may be used to divide benefits for this purpose. Deviations from these percentages should be used where physical data indicate a more equitable division.

III. COSTS

A realistic appraisal of all costs is just as important as an adequate appraisal of benefits. Local practices in contracting, availability of contractors and needed equipment, costs of similar jobs and physical conditions which would affect costs should all be taken into consideration in preparing cost estimates.

A. Types of Cost

1. Project Costs

Project costs may include, but are not limited to the type of costs listed below.

Easements and rights-of-way
Clearing right-of-way
Relocation or rebuilding of roads, bridges, culverts and fences
Excavation of main canals, ditches and laterals
Stabilization of canals, ditches, or laterals
Motor and pumps
Legal fees
Contingencies
Installation services in field surveys design, preparation of specifications, contracting, layout and supervision.

Annual operation and maintenance

These may in various combinations make up installation costs or be a part of annual maintenance costs. General instructions as given in the Watershed Planning Handbook are to be followed.

2. Associated Costs

In general, all on-farm capital costs and farm production costs required with drainage facilities are considered as associated costs. Of these, farm production costs and the installation and maintenance cost of land treatment measures and practices that require annual re-establishment or have an economic life less than five years are included in the budgetary analyses.

Land treatment measures, or other on-farm capital expenditures with an economic life in excess of five years are normally amortized over their economic life at an interest rate available to farmers over the life of the facility. The annual equivalent of these capital costs plus their operation and maintenance costs are then deducted from the increased agricultural income with the project to derive benefits to the drainage measures.

Examples of associated costs for a drainage project that are normally included in the budget analyses are: (1) increased tillage operations, materials and supplies; (2) additional taxes; (3) re-occurring land treatment practices and/or measures; and (4) the annual operation and maintenance of these measures.

Associated costs that are on-farm capital expenditure would include; on-farm field drains, land clearing; buildings and equipment; and the annual maintenance costs of these expenditures, etc.

3. Induced Costs

All induced costs should be taken into account where necessary in preparing a benefit-cost ratio for drainage projects. In the analysis, these are handled in the same manner as are project costs. An increase in floodwater damages (usually due to more intensive cropping and higher damageable values) can be treated as an induced cost. Another example would be the damaging effects to fish and wildlife habitat and production.

B. Cost Analysis

1. Amortization Period

In comparing benefits to costs both items are placed on a comparable basis--annual benefits versus annual costs. In relating costs to an annual equivalent the total installation costs of the project or separable parts thereof are amortized at the interest rate established for project

evaluation over their expected useful economic life or a period of 100 years, whichever is less.

2. Annual Cost

The annual cost of a project includes the amortized values of the total installation cost, operation and maintenance cost, and any induced costs.

CHAPTER 7

IRRIGATION MEASURES

Irrigation measures produce benefits that consist primarily of increases in annual agricultural income resulting from the increased production of agricultural commodities. These benefits are mainly on-site and may include the following: (1) the value of increased production of agricultural commodities less any increase in variable production costs, cost of land treatment measures and other on-farm capital expenditures associated with the increased production; (2) reduced cost in the operation and maintenance of the present irrigation facilities; and, (3) other benefits, although not entirely evaluated in monetary terms, such as improved wildlife habitat, reduction in health hazard, etc.

I. BASIC DATA

To determine the physical and economic feasibility of irrigation measures, it is necessary to collect and analyze certain basic data. This data, for project analysis, must be stated in terms of what can be accomplished without a project as well as what can be accomplished with various increments of project development. Data to be analyzed are as follows:

A. Water Supply, Water Rights and Water Quality

Water supply defines the availability of water for irrigation development. It may vary by season and area, thereby requiring special attention to types of measures, selection of priority crops, and separate evaluation areas. Water supply is generally the most significant factor affecting land use and yield response in irrigation projects. Hence, an essential step in the analysis is to determine, at some specified location, the availability of water supply with and without a project.

Water rights are of two broad types-riparian and prior appropriation. Water rights are set by state law and may limit the amount of water available for project purposes.

Water quality is generally related to its pH, salinity, and sediment load, any one of which can affect crop yield.

B. Soils

Soils data for the present and proposed irrigated area should be collected and grouped in accordance with similarities in crop adaptability and irrigation characteristics.

C. Land Treatment Needs

Estimates must be made of the amounts of each kind of land treatment measures required with each increment of project development. The amounts must be based on a realistic appraisal of the capabilities of

the farm operators and their ability to finance the improvements. However. the amounts should not be less than required to meet agreed upon conservation objectives in the use of soil and water resources.

D. Consumptive Use by Crops

Crops vary in their demand for water. Consumptive use includes all transpiration and evaporation losses from lands on which there is growth of vegetation of any kind, plus evaporation from water surfaces. Factors which influence consumptive use are climate, temperature, soils, wind movement, stage of development of the plant and its foliage. Data relating to the consumptive use of crops must be known before determining future land use and crop yields.

E. On-Farm Irrigation Efficiency

Water application efficiency is defined as the ratio of the volume of water that is stored in the soil root zone and ultimately consumed (transpired or evaporated, or both) to the volume of water delivered at the farm. Several factors such as depth of soil, topography, type of crop, etc., affect on-farm irrigation efficiency. Improvements in efficiency level can be achieved through improved methods of water application and improved water management practices. Generally, higher rates of efficiency are associated with more economic production of crops. As on-farm irrigation efficiency, consumptive use of crops and water supply are inter-related, each is important in considering project effects. The present level of on-farm irrigation efficiency should be determined and estimates should be made of future levels that can be achieved with and without the project.

F. Land Use and Crop Yields

Land use and crop yields under present conditions may be determined through interviews of farm owners and operators for each of the major soil groupings. In areas presently irrigated, this data should be collected for situations where the full irrigation water requirements of the crops are met and for situations where the irrigation water requirements of the crops are met for only a portion of the cropgrowing year. This information will be the basis for projecting crop use and yields for "with" and "without" project conditions.

Data under present conditions should be collected from all reliable sources. Information may be obtained from farm records, informed local sources, county and state reports and other published data.

Estimates of future land use and crop yields in response to water supply form the basis of determining irrigation benefits. Estimates of yields must be reasonable and well documented. Sources of secondary information that may be used include surveys of past trends and published reports relating to projections. Data from areas outside the project boundary may be used if soils, climate, water supply and other production factors are

similar. Generally, it is considered that within the long run average yields by soils and available water will at least be equal to those obtained by the best farmers today. In estimating future crop yields consideration must be given to the availability of water to meet all crop demands for the growing season. When less than a full supply is provided, consideration must be given to priority crops.

Land use estimates, where less than a full water supply is provided for the area and crops under consideration, must be based on priority crops. Available water supply, peak consumptive use by months, relative net returns of crops and demands placed upon the crop are important considerations in assigning priority crops. Crops are normally considered as first, second and third priority crops. Crops of first priority would receive first consideration in the distribution of water with crops of the lowest priority receiving the remaining supply or no supply during short water supply years.

In estimating future yields under non-project conditions, assume the application of land treatment measures and adoption of technological improvements that can reasonably be expected in the absence of the project.

Estimates of future yields with the project should be based on the application of land treatment measures required with each increment of project development. Estimates should include the adoption of technological improvements that can reasonably be expected with the project.

The same period of time must be used for both future estimates.

G. Partial or Complete Budget Analysis

Benefits to irrigation measures stemming from improved production and yield of agricultural commodities are expressed as an increase in agricultural income less any increase in variable production costs or other costs associated with the increase. Therefore, estimates of agricultural income must be determined for both "with" and "without" project conditions.

Budgets may be used to estimate agricultural income for both "with" and "without" project conditions. Depending upon circumstances, the budget analysis used may vary from a simple partial analysis to a more complete enterprise analysis.

Where additional water is used to augment existing supplies and little or no change is expected in the area irrigated or in the cropping pattern, a partial crop enterprise analysis may be used. Here, any increase in agricultural income can be measured as the difference in gross crop returns with and without the project less any variable production costs associated with the increase.

Where changes are anticipated in the economic base of the agricultural producers because of the irrigation project, differences in variable production costs may be so great that an adequate accounting of these changes will require a more detailed analysis. These may include the

following: (1) individual crop budgets for the irrigated area or lands associated with the irrigated area; or (2) an overall farm or ranch analysis.

II. BENEFITS

A. Source.

Benefits to irrigation measures are similar to benefits from changed land and more intensive use of flood plain land. That is, benefits occur as a project caused increase in agricultural income. These benefits are mainly on-site and may include the following:

1. Land Use Changes

With new developments or with improvements in existing projects it may be possible to cultivate areas that have never been in cultivation before. For example, land that has always been in woods, pasture or wild land may be cleared and converted to irrigated cropland. Consideration must be given to soils, topography, accessibility to water supply, etc. Policy limitations may limit the extent of benefits claimed from "new land".

2. More Intensive Use

Another source of benefits is the more intensive use of existing croplands. With available water, irrigated crops may be substituted for dryland crops. Or, irrigated crops having a low marginal return in response to an increasing supply of water may be replaced by crops with a higher margin of return.

3. Reduced Production Costs

With the project, savings may be made in crop production costs. For example, fields may be re-arranged, allowing a more efficient use of farm equipment, some tillage operations or the number of times over of a particular operation may be reduced, and a saving in labor to irrigate may occur with improved water applications. On the other hand, costs may be incurred with the project that would not be necessary without the project. These costs, additions or subtractions, should be handled in the budget analysis.

4. Improved Allocation of Resources

A re-allocation of resources in the farming and ranching operations of the project area may occur as a result of the irrigation project. With the removal or reduction of certain risks, capital rationing may be reduced. For example, farmers may now find it profitable to invest in improvements, change their type of farming, and shift their crop pattern between the non-irrigated and irrigated area. Therefore, to measure adequately the effects of the project on the agricultural income of the area, where these types of changes are anticipated, an overall farm or ranch analysis should be made rather than an individual crop analysis. This is particularly true in areas primarily engaged in livestock production.

5. Reduced Project Operations and Maintenance Cost

Where project works of improvement augment or supplement the present irrigation facilities, the operation and maintenance cost of the present facilities may be replaced by the project's operation and maintenance cost. The accounting of this benefit can best be handled by including the full project operation and maintenance cost in the annual cost of the project and the replaced (non-project) operation and maintenance cost in the benefit analysis.

B. Agricultural Income With and Without a Project

To measure the effects of the project on the agricultural income of the area, estimates must be made of the future income levels for both "with" and "without" project conditions. To test alternatives for project formulation estimates of income with each increment of project development may be necessary.

Although other systems may be employed in measuring the response of crops from full season and part season irrigation, the following approach is recommended in determining physical results.

1. Determine the number of acres that can be provided full season irrigation and the acreage that can be irrigated only part of the season (one month, two months, etc.)

a. With the land treatment measures that can reasonably be expected to be applied in the absence of a watershed project.

b. With improvements in water conveyance facilities and delivery schedules in addition to the land treatment measures that can reasonably be expected to be achieved without a watershed project.

c. With each system of structural measures considered, together with the land treatment measures that are needed and feasible which will most nearly meet the needs of a successful irrigation project.

With the physical information from above and with the compiled data on land use and yields for full and partial water supply, levels of income should be computed for steps B1a and B1c. The difference in these two levels of income is an increase in agricultural income attributable to the structural and the associated land treatment measures of the irrigation project.

In determining income, consideration should be given to the effects that the project may have on prices received and paid. For example, with the development of a project, the area may change from an importing to an exporting area for certain crops (i.e. forage or feed crops). Also, in areas producing more pasture and feed with the project, the demand for livestock to utilize this feed may become so keen that the farmers would bid their margin of profit away.

C. Evaluation of Benefits to the Irrigation Measures

Benefits to the irrigation measures are equal to the increase in agricultural income attributable to the structural and associated land treatment measures of the project less any associated costs (on-farm capital expenditures) not included as a variable production cost in the budget analyses.

1. Allowance for Lag in Accrual

Full project benefits may not be instantaneous with project installation. This is particularly true for projects requiring considerable change in the level of farm management. When this situation exists, benefits should be discounted for the expected lag in accrual.

III. COSTS

A. Type of Costs

1. Project Costs

These costs include the value of goods and services used for the establishment, maintenance and operation of the project including allowances for induced adverse effects.

Examples of project costs common to irrigation developments are:

Water Measuring Devices
Canal Lining
Procurement of Water Rights
Turn-Out-Structures
Main and Lateral Canals, etc.

2. Associated Costs

Other costs not directly concerned with project installation but incurred in order to make available the products of the project or facility are called associated costs. In general, all on-farm capital costs and farm production costs required with irrigation projects are considered as associated costs.

Farm production costs and the installation and maintenance cost of land treatment measures and practices that require annual reestablishment or have an economic life less than five years are reduced to an average annual cost and included in the budget analysis.

Land treatment measures or other on-farm capital expenditures with an economic life in excess of five years are normally amortized over their economic life at an interest rate available to farmers over the life of the facility. The annual equivalent of these capital costs plus their operation and maintenance costs are then deducted from the increased

agricultural income with the project to derive benefits to the irrigation structural measures.

Examples of associated costs that are included in the budget analysis are: (1) labor to irrigate; (2) increased tillage operations, materials and supplies; (3) additional taxes; (4) establishment of perennial crops; (5) land smoothing, on-farm ditch maintenance, stubble mulching, etc.; and (6) the annual operation and maintenance of these measures.

Examples of on-farm capital expenditures are: (1) land leveling, drainage ditches, on-farm irrigation structures, sprinkler systems; (2) buildings and equipment; and (3) the annual operation and maintenance of these measures.

3. Induced Costs

These costs include all adverse affects in goods and services caused by construction or operation of a project. Examples of such costs may be the need for drainage of areas made too wet for sustained agricultural production by the irrigation system.

B. Cost Analysis

1. Amortization Period

In comparing costs to benefits both items are placed on a comparable basis - annual benefits versus annual costs. In relating costs to an annual equivalent, the total installation costs of the project or separable parts thereof are amortized at the current federal interest rate over their expected useful economic life or a period of 100 years, whichever is less.

2. Annual Cost

The annual cost of a project includes the amortized values of the total installation cost, operation and maintenance cost, and any induced costs.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Washington 25, D. C.

December 19, 1962

WATERSHEDS MEMORANDUM SCS-61

Re: Policy for Advancing Funds for the Acquisition of Land, Easements, or Rights-of-way

Section 103 of Public Law 87-703, approved September 27, 1962, amends Public Law 566 by authorizing the Secretary of Agriculture to advance construction funds to local organizations for the purchase of land, easements, or rights-of-way when immediate purchase is essential to preserve sites for works of improvement proposed in approved watershed work plans. This authority is applicable to Public Law 566 projects and to the eleven watershed programs authorized by the Flood Control Act of 1944. The purpose of this memorandum is to establish the policies under which this authority will be carried out. These policies are effective immediately.

Funds will be made available to local organizations who have legal authority to purchase land, easements, or rights-of-way only after (1) a watershed work plan has been approved (2) the Service and the local organization have mutually determined that immediate purchase is necessary to assure the site's use for project purposes, and (3) the Farmers Home Administration has approved the arrangements for repayment of the advance.

Interest charges will begin to accrue as soon as funds are advanced to the local organization at the rate determined in accordance with the provisions of Section 8 of the Act. The repayments will be credited to construction funds by transfer from the Farmers Home Administration.

Advance of these funds will in no way affect the eligibility of the local organization to obtain loans under the provisions of Section 8 of the Act if it is otherwise eligible for such loans. The loans may be made to help local organizations repay the amounts advanced prior to construction.

D. A. Williams

STC
EWP
WF
WD

OUTLINE FOR

FORMULATION AND EVALUATION OF

IRRIGATION MEASURES IN

P. L. 566 WATERSHED PROJECTS

Portland Engineering and Watershed Planning Unit

August 1964

PREFACE

This Outline is intended to serve as a guide for the collection and use of data in project formulation and project evaluation, for irrigation features of P. L. 566 watershed projects. It also will be applicable to projects where irrigation benefits incidentally accrue to other project purposes and will be useful in the planning of irrigation measures under other programs. Use of the outline will assist planning staffs with the irrigation aspects of the watershed program, and adherance to the principles of the outline will result in a uniform approach to formulation and evaluation of project measures.

The Outline is not intended to indicate a fixed chronological order of procedure. Much of the information needed at various levels of the analysis may already be available. Many of the investigations can be carried on concurrently. The procedure shown in the outline may be subject to modification when particular project conditions warrant such consideration.

The Outline does not go into work plan preparation or format. This is covered in the Watershed Protection Handbook. It will be noted that the Outline calls for development of some information that will not be shown directly in the work plan, but which is of vital importance in the proper formulation of project measures.

OUTLINE FOR PROJECT FORMULATION AND EVALUATION
P. L. 566 Irrigation Improvement Projects

Page No.

A. MAPS

1. Watershed Area 1
2. Irrigated Area 1

B. IRRIGATION INVESTIGATIONS & FUNCTIONAL REQUIREMENTS

1. Irrigation Water Supply 2
2. Soil & Crop Acreages 2
3. Location, Elevation and Climate 3
4. Crop Yields. 3
5. Land Treatment Requirements 4
6. Unit Net Irrigation Requirements 5
7. Farm Irrigation Efficiencies 6
8. Unit Farm Water Delivery Requirements 7
9. Conveyance Losses 7
10. Operation Losses 7
11. Water Storage 8
12. Water Supply--Water Demand Analyses, and Computations of Physical Benefits of Project Measures . . 9
13. System Capacity Requirements 9

C. COSTS

1. Land Treatment Measures 11
2. Structural Measures 11

D. PROJECT EVALUATION

1. Income 12
2. Irrigation Benefits 13
3. Benefit-Cost Relationships 14

OUTLINE FOR PROJECT FORMULATION AND EVALUATION
P.L. 566 Irrigation Improvement Projects
Western Region
January 1963

A. MAPS.

1. Watershed Area

Show location of irrigated areas and/or new areas proposed for irrigation.

Show reservoirs and proposed reservoir sites.

Show present and proposed diversion points, main canals, and other major irrigation structures.

2. Irrigated Area

Show major topographic and cultural features such as main waterways, roads, drains, etc. (If an aerial mosaic is used as a base, many of these features will be evident).

Show complete water distribution facilities and identify proposed project structural improvement measures.

Facilities to be shown include lined and unlined canals and laterals, flumes, pipelines, measuring devices, checks, farm turnouts, and other major structures.

Show lands now receiving water and additional land (if any) proposed for irrigation.

In cases where water is delivered to farms by more than one organization or where there is more than one source of water, it may be desirable to identify the lands served by each organization or water source.

Delineate soil boundaries. (A separate soils map may be desirable).

Show soil mapping units, or group soils according to crop adaptability and irrigation characteristics.

In establishing soil groups, consider soil profile characteristics, soil depths, available moisture holding capacities, intake characteristics, wetness, salinity, alkalinity, land slopes, and other factors that affect crop adaptability, crop yields, or suitability for irrigation.

B. IRRIGATION INVESTIGATIONS AND FUNCTIONAL REQUIREMENTS.

1. Irrigation Water Supply

Determine watershed yield, on monthly basis, at irrigation diversion points or, if applicable, as reservoir inflow.

Use gaging records or other yield data to develop a frequency curve of annual yield. From this curve the yield having a satisfactory probability of occurrence can be selected. The 80% chance yield will usually be considered the dependable supply.

Use the average monthly distribution of yield in percent of total to obtain the monthly distribution of the yield at the selected frequency.

Determine what portions of the monthly yields are available for project use.

Consider water rights, minimum stream flow requirements, and other factors that might affect availability.

If groundwater is available, determine where and how much water can be obtained from this source.

2. Soil and Crop Acreages.

Determine the acreages of the different kinds of soils in the areas now irrigated and in proposed new areas.

Soils should be grouped in accordance with similarities in crop adaptability and irrigation characteristics. (See A-2).

Determine the acreages of the different kinds of crops now grown in the irrigated area and in areas proposed to be irrigated. The crop acreages should be determined separately for each soil group.

Determine the kinds of crops that could be expected to be grown on the irrigated lands in the future as a result of a continuation of going programs (no project), and estimate the acreage distribution in each soil group.

Determine the kinds of crops that are expected to be grown on the irrigated lands after project developments, and estimate the acreage distribution in each soil group.

3. Location, Elevation and Climate

Determine mean latitude and longitude of the irrigated area.

Determine mean elevation of irrigated area.

Determine mean monthly precipitation in irrigated area.

Determine mean monthly evaporation in irrigated area.

Determine mean monthly temperatures in irrigated area.

Determine mean spring and fall frost dates.

Determine dates for both 32° and 28° minimum.

4. Crop Yields.

Determine, for each soil group, the average crop production levels under present conditions for each crop of significant importance now grown in the irrigated area or in areas that are proposed to be irrigated.

In irrigated areas, determine yields for situations where the full irrigation water requirements of the crops are met and for situations where the full irrigation water requirements of the crops are met for only a portion of the crop growing period.

Estimates of crop yields should be based on information and data from all reliable sources. Information may be obtained from existing farm records of crop yields and available water supplies; from county reports; and from studies made by such agencies as the Extension Service or the Agricultural Experiment Station. Data from areas outside the watershed may be used if soils, climate, water supply, and other production factors are similar. It may be necessary to supplement these records with measurements of crop water applications and crop production made on selected representative sample fields during at least one crop season.

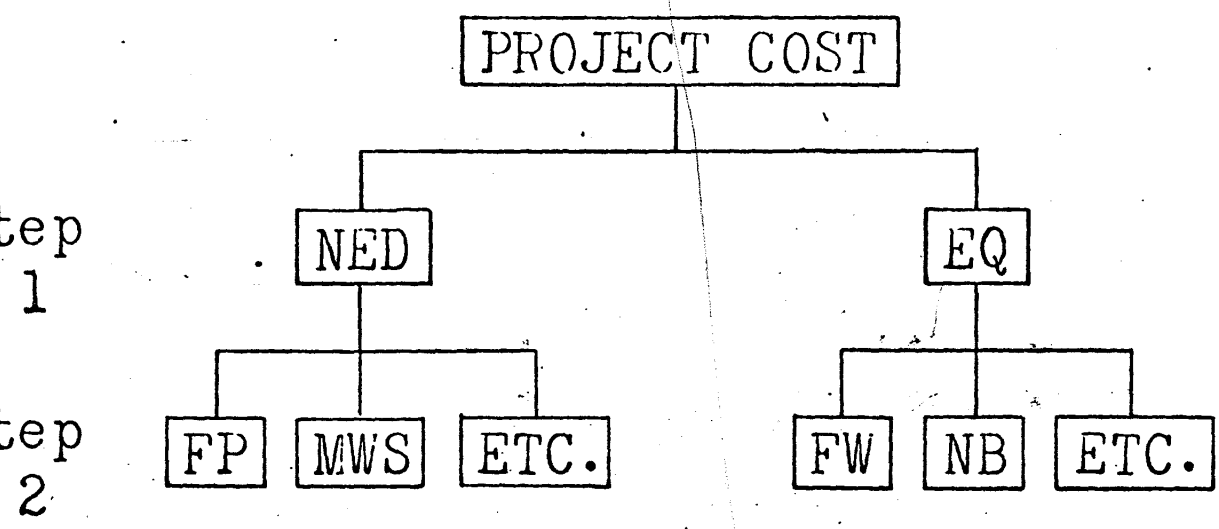
Determine by soil groups, the average production levels to be expected to result from a continuation of going programs (no project).

In estimating yields under non-project conditions, assume the application of land treatment measures and adoption of technological improvements that can reasonably be expected in the absence of a watershed project.

COST ALLOCATION

IN

MULTIOBJECTIVE PLANNING

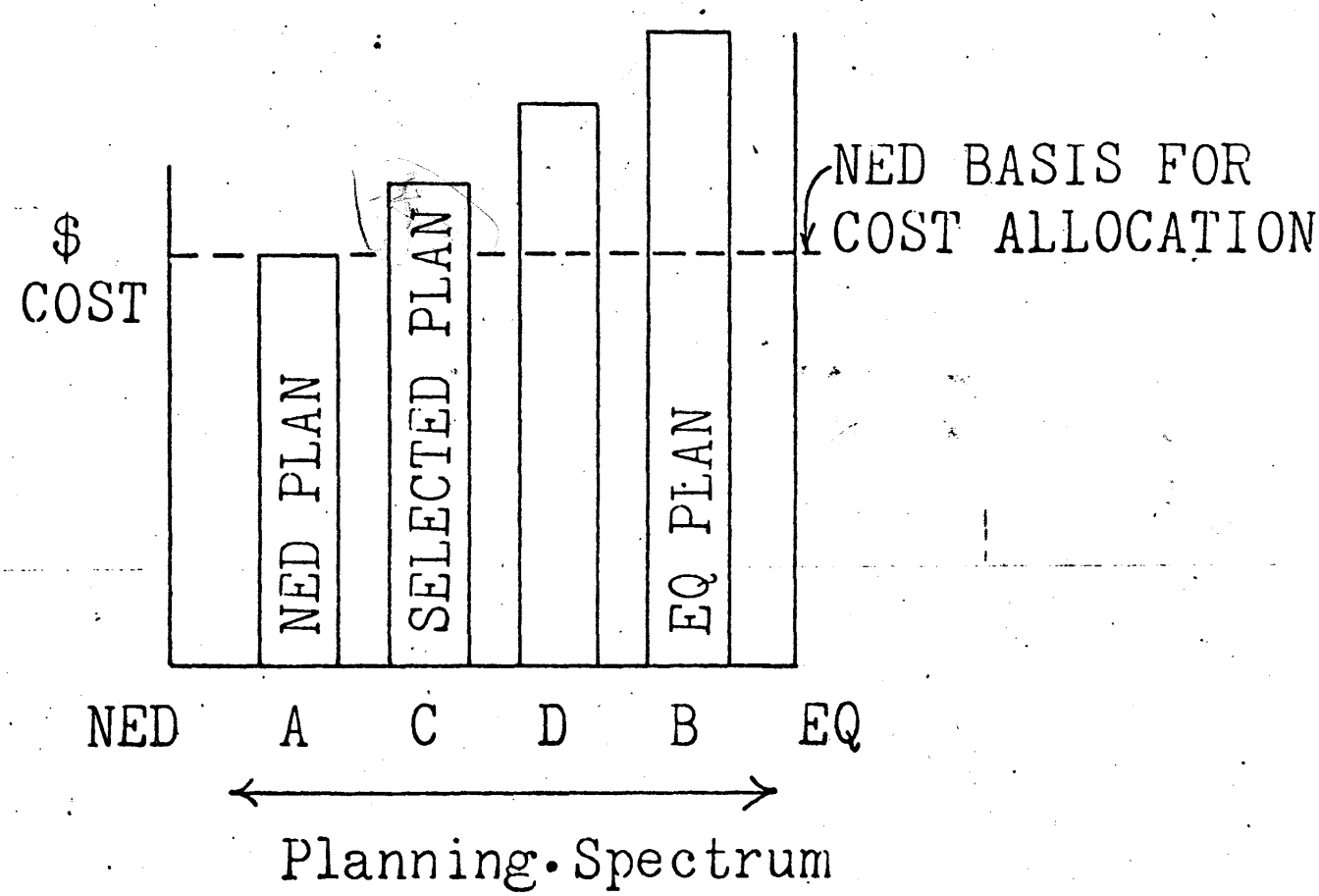


Note: Allocation confined to NED costs.

Second stage allocation limited to plans involving multiple functions (purposes) of the objectives.

SCRB will be used in plans involving multiple purpose reservoirs.

STEP 1 -- ALLOCATION TO OBJECTIVES



If a plan has pure environmental enhancement in a single purpose F.P. plan, then it is multiobjective and will require cost allocation.

EXAMPLES -- ALLOCATION TO OBJECTIVES

CASE #1 - Costs and Benefits of selected plan are greater than NED plan costs and benefits.

DATA:

	NED Plan	Selected Plan
Costs	160	175
Benefits	245.	250

ALLOCATION TO OBJECTIVES:

Gross Incremental Benefits	+ 5
Less: Gross Incremental Costs (-)	+15
Net Incr. Costs Allocated to EQ	10

CASE #2 - Costs of selected plan larger than NED plan, benefits smaller.

DATA:

	NED Plan	Selected Plan
Costs	160	175
Benefits	245	235

ALLOCATION TO OBJECTIVES:

Gross Incremental Benefits	-10
Less: Gross Incremental Costs (-)	+15
Net Incr. Costs Allocated to EQ	25

CASE #3 - Costs and benefits of selected plan less than NED plan costs and benefits.

DATA:

	NED Plan	Selected Plan
Costs	160	150
Benefits	245	230

ALLOCATION TO OBJECTIVES:

Gross Incremental Benefits	-15
Less: Gross Incremental Costs (-)	-10
Net Incr. Costs Allocated to EQ	5

TC
- INC Cost
- Separable Cost
Joint Cost

STAGE 2

STEP 2 - ALLOCATION OF NED COSTS TO FUNCTIONS (PURPOSES)

MUST USE SEPARABLE COST REMAINING BENEFITS (SCRB) METHOD.

Special Terms used in Cost Allocation - WPH 103.018

Alternative Cost - The alternative cost of each purpose is defined as the cheapest cost of achieving the same or equivalent benefits in single purpose structures that will accrue to each purpose in the multiple-purpose structure.

Specific Cost - Specific costs are those costs incurred solely for a single purpose.

Separable Cost - The separable cost for each project purpose in a multiple-purpose structure is the difference between the cost of a multiple-purpose structure and the cost of the structure with that purpose omitted. Plan B w/ FP Rec IRR

B - FP

B - Rec

Joint Cost - The joint cost is the difference between the cost of a multiple-purpose structure and the sum of the separable costs of the purposes included in the structure. When the estimate of separable costs cannot be made or is unduly burdensome to make, joint costs may be considered to be the difference between the multiple-purpose cost and the sum of specific costs for each purpose.

STEP 2 - ALLOCATION TO FUNCTIONS (PURPOSES)

Assume a project with two multiple objective reservoirs - both with flood prevention, one with M&I, the other with recreation. In the flood plain, there is a need to protect the natural beauty of the area, plus a need for protecting a historical resource from flooding.

A. DATA - (refer to step 1, case 2)

	NED Plan	Selected Plan
Costs	160	175
Benefits		
FP	110	100
M&I	75	75
REC	60	60
EQ	--	--
Total	245	235

Project Cost	175
Project Cost with FP excluded	150
Project Cost with M&I excluded	145
Project Cost with REC excluded	150
Project Cost with EQ excluded	160

	Alternative Cost	Separable Cost
FP	80	25
M&I	60	30
REC	75	25
EQ	40	15
(NB)	(19)	--
(EF)	(21)	--

B. ALLOCATION OF COSTS TO NED FUNCTIONS (PURPOSES)

	FP	M&I	REC	TOTAL
a. Benefits	100	75	60	235
b. Alternative Costs	80	60	75	
c. Maximum Justifiable Expenditure (lesser of a or b)	80	60	60	
d. Separable Costs	25	30	25	80
e. Remaining Benefits (c-d)	55	30	35	120
(percent)	(46)	(25)	(29)	
f. Allocated Joint Costs	32	18	20	70
g. Total Allocated Costs (d + f)	57	48	45	150

See Sheet 1

SUMMARY OF TWO-STAGE COST ALLOCATION

Stage I

Plan	Costs		
	Total	NED	EQ
A. (NED)	160	160	0
C. (Selected)	175	150	25

Stage II

Plan	Costs					
	Total	NED			EQ	
		FP	M&I	REC	NB	EF*
C. (Selected)	175	57	48	45	12	13

*Environmental flooding

POSSIBLE TABLE 2A
COST ALLOCATION AND COST SHARING

SOURCE OF FUNDS	Costs by Purpose			
	FP	M&I	REC	NB
Total	70*	48	45	12
Federal	70	0	22	0
Nonfederal	0	48	23	12

*Includes 57 NED damage reduction and 13 EQ damage reduction costs

Principles & Standards Cost Allocations

Principles and Standards prescribe the use of the Separable Cost Remaining Benefits Method for cost allocations. The prescription is a modified two step version of this allocation method. The first step in the procedures is to allocate the measures costs to the two planning objectives, NED and EQ. The second step is to allocate the NED costs of multiple purpose reservoirs to the components (purposes) serving the NED objective. The Separable Cost Remaining Benefits Method will be used in lieu of the Use of Facilities Method.

Step One

The allocation of cost to EQ and NED involves the comparison of the NED plan with the alternative plan. The net incremental cost of serving the EQ objective is allocated to EQ. The net incremental cost may represent the additional monetary cost less any additional monetary benefits or benefits foregone less any reduction in costs. These are described in Chapter VII of the USDA procedures as two cases. The first case is where both the monetary benefits and costs of the recommended plan are larger than the NED plan but the added costs to serve the EQ objective are greater than the added NED benefits (NED benefits). In this case the added benefit is deducted from the added cost to determine the net incremental cost allocated to the EQ objective. The EQ cost is subtracted from the total cost to determine the cost allocated to the NED objective.

The second case is when the monetary benefits and costs of the recommended plan are both less than in the NED plan. The reduced costs are deducted from the reduced benefits to determine the net benefit foregone. The net

---

Presented at the 1975 Principles and Standards Workshops in the South Technical Service Center area by Tom Hodges and Robert Rubel.

incremental cost allocated to EQ is equal to the net benefit foregone. The remainder of the total cost is a NED Cost.

Step Two

The second step in the procedure is the allocation of NED costs for multiple purpose reservoirs to components (purposes) using the Separable Cost Remaining Benefits Method. The first part of the procedure is to compare the NED benefits for each component with the alternative cost of the cheapest single purpose measures to attain the benefits. The lesser of these two limit the benefits for each components to be used in the allocation. In addition this limits the amount of cost that can be allocated to each component.

The next part is to determine the separable costs. These are the costs of adding each component as the last increment in the multiple purpose reservoir. To do this cost estimates are needed for the reservoir with each component omitted. The differences between the multiple purpose cost and each cost with components omitted are the incremental costs or separable costs. The separable costs are the first of the costs allocated to each component.

The third part of the procedure is to determine how much of the benefits to each component is remaining after the separable costs are subtracted. These are called remaining benefits. The percentage distribution of remaining benefits by components is used to allocate the rest of the costs (joint costs)

The fourth part is to determine joint costs to be allocated to each component. The joint cost is the difference between the total multiple purpose cost and the total of the separable cost.

The fifth part is to allocate the joint cost to each component. This is

done by multiplying each component's percentage of the remaining benefits to the joint cost.

The last part is to add the separable cost for each component with the joint cost allocated to each component to determine the total cost allocated to each component. If recreation is one of the components the allocation of land rights costs will need to be modified to comply to established procedures set forth in the Watershed Protection Handbook and RC&D Handbook.

Data needed to work the allocations is as follows:

1. NED benefits for each component
2. Costs for the component elements (measures) in the NED plan
3. Costs for the component elements (measures) in the alternative plan.
4. Costs for the multiple-purpose measure or measures with each component omitted.
5. Alternative costs for single-purpose measures to attain component benefits.

With this allocation method all benefits and costs will need to be either annual or capitalized values. The use of capitalized values involves less work. The reason for this is only the benefits will need to be capitalized instead of converting all cost estimates to annual values and capitalizing the allocated costs at the end of the process.

It is best to work the allocation with construction, engineering, land rights, relocation payments and OM&R costs as separate items. When this is done the figures are ready for the account displays and work plan

tables.

The first step of the allocation procedures will be needed for all measures, even single-purpose measures, when they serve both the NED and EQ objectives. This step will be needed for all plans other than the NED plan. All costs in the NED plan are NED costs. In plans alternative to the NED plan, all measures in an evaluation unit will need to be carried through the allocation as a group.

The second step of the allocation will need to be carried out when multiple-purpose reservoirs are a part of the system. Multiple-purpose channels costs are to be allocated using methods described in the Watershed Protection Handbook and Economics Guide. When multiple-purpose reservoirs are involved along with single-purpose measures or multiple-purpose channels in an evaluation unit all measures will need to be carried through SCRB. This applies to RC&D and P. L. 566 plans. The second step of the allocation will not be carried out for River Basin plans. Only the first step will be used for River Basin planning.

2/4/75 TCGH

Application of SCRB For Evaluation Units

The procedures for the use of the two stage allocation in the Principles and Standards and the USDA Procedures are intended for single multiple purpose structure application. When we attempt to apply the allocation to an entire evaluation unit, where both single purpose structures and multiple purpose structures have a common benefited area, a slight adjustment is required. In such cases the total NED costs are used to compute separable costs for the multiple purpose structures as proscribed in the P & S and USDA Procedures. However, we will need to deduct the allocated EQ costs from the single purpose measures so that these costs are not transferred to the multiple purpose structures when we compute the remaining joint costs. The Separable Cost Remaining Benefit Method will work just fine if we use only NED allocated costs for single purpose measures when computing separable costs and remaining joint costs. This is demonstrated in the "Illustration of Cost Allocation With Principles and Standards" presented at the STSC P&C workshops.

COST ALLOCATION METHOD

A. PROJECT DATA

NED OBJECTIVE	NED PLAN	RECOMMENDED PLAN
BENEFITS		
FLOOD PREVENTION	$ 40	$ 41
RECREATION	60	50
TOTAL	$ 100	$ 91
COSTS		
PROJECT INSTALLATION AND OM&R	$ 55	$ 50
NET BENEFITS	$ 45	$ 41

B. ALLOCATION OF NED COSTS AMONG OBJECTIVES

1. EQ ALLOCATION

NED OBJECTIVE	NED PLAN	RECOMMENDED PLAN	DIFFERENCE
BENEFITS	$100	$91	$-9
COSTS	55	50	-5
NET BENEFITS	$45	$41	$-4

THUS: GROSS INC. NED COST = $5

NET INC. NED COST ALLOCATED TO EQ = $4

2. NED ALLOCATION

TOTAL RECOMMENDED PLAN COST	$50
LESS COST ALLOCATED TO EQ	4
COST ALLOCATED TO NED	$46

C. ALLOCATION OF NED COSTS AMONG COMPONENTS OF THE NED OBJECTIVE

1. SEPARABLE NED COSTS FOR NED COMPONENTS

	RECOMMENDED PLAN	F.P. OMITTED	REC. OMITTED
TOTAL NED COSTS	$50	$35	$24

	FLOOD PREVENTION	RECREATION
SEPARABLE NED COSTS	$15	$26

2. REMAINING JOINT NED COSTS OF NED OBJECTIVE

TOTAL NED COSTS	$46
LESS TOTAL SEPARABLE	41
REMAINING JOINT NED COSTS	$5

3. NED SCRB COST ALLOCATION

	NED COMPONENTS		
	FP	REC.	TOTAL
1. BENEFITS	41	50	91
2. ALT. NED COSTS	19	28	47
3. BENEFITS LIMITED	19	28	47
SEPARABLE NED COSTS	15	26	41
5. REMAINING BENEFITS (% DISTRIBUTION)	4 (66.7%)	2 (33.3%)	6 (100%)
6. REMAINING JOINT NED COSTS	3.5	1.5	5
7. TOTAL ALLOCATED NED COSTS	18.5	27.5	46

Lower Columbia Water Resource Sub Area No. 1713

Part B - 100yr Evaluation period at 4 5/8 %

Growth beyond 2020 based on a linear regression of OBERS PROJECTIONS FROM 1970-2020.

6. 15378 (2030) - 14345 (2020) = 1033

a. 1033 ÷ 10yr = 103.3 X 40.33035 (P.V. of INC ANN, 10yr) X .10429 (PV 1, 10yr) = 434.5

b. 1033 X 18.67782 (PV am 1 per, 40yr) .06635 (PV of 1 60yrs) = 1239

7. 17443 (2040) - 15378 (2030) = 2065

a. 2065 ÷ 10yr 206.5 X 40.33035 (PV of INC ANN, 10yr) X .06635 (PV 1, 60yr) = 552.6

b. 2065 X 16.05202 PV am 1 1yr, 30yr X .04222 (PV. of 1, 70yrs) = 1399.5

8. 19508 (2050) - 17443 (2040) = 2065

a 2065 ÷ 10yr 206.5 X 40.33035 (PV of INC ANN 10yr) X .04222 PV 1, 70yr) = 351.6

b 2065 X 12.86818 PV of 1, am 1yr, 20yr X .02686 (PV of 1, 80yrs) = 713.7

9 21574 (2060) - 19508 (2050) = 2066

a. 2066 ÷ 10yr 206.6 X 40.33035 (PV of INC ANN 10yr) X .02686 (PV 1 80yr) = 223.8

b 2066 X 7.86431 (PV of An of 1, 10yr) .01709 (PV. of 1, 90yrs) = 277.7

10. 23639 (2070) - 21574 (2060) = 2065

a 2065 ÷ 10yr = 206.5 X 40.33035 (PV of INC ANN. 10yr) X .01709 (PV 1 90yr) = 142.3

b

Sum of above calculations 434.5 + 1239 + 552.6 + 1399.5 + 351.6 + 713.7 + 223.8 + 277.7 + 142.3 = 5334.7

Lower Columbia
PO-3 Factor
4 5/8 %
by le 24 Aug 74
1 of 3

Lower Columbia Water Resource Sub Area No. 17.13

	1969	1970 1/	1980 OBERS	1990	2000	2010	2020	2030 Linear Regression	2040	2050	2060	2070
...ter 1967	3603	3960	4914	6283	8,403	10994	14345	15378	17443	19508	21574	23639

PO-3 Discounting Procedures for Determining Income factors

Part A Discounting Procedure for Determining Income factors 50yr @ 4 5/8 %

1. 4914 (1980) − 3960 (1970) = 954

   a. 954 ÷ 10yrs = 95.4 × 40.33035 (P.V. of inc. ann. 10yr.) = 3847.5

   b. 954 × 18.07782 (P.V ann. of 1 per year, 40yr.) × .63628 (P.V of 1, 10yr) = 10,973.4

2. 6283 (1990) − 4914 (1980) = 1369

   a. 1369 ÷ 10yr = 136.9 × 40.33035 (PV of inc ann. 10yr.) × .63628 (P.V. of 1, 10yr) = 3513

   b. 1369 × 16.05202 (P.V ann of 1/yr 30yr) × .40485 (PV of 1, 20yrs) = 8896.6

3. 8,403 (2000) − 6283 (1990) = 2120

   a. 2120 ÷ 10yrs = 212 × 40.33035 (PV of inc ann. 10yr) × .40485 (PV, 1, 20yr) = 3461.5

   b. 2120 × 12.86818 (P.V. ann. of 1 per yr., 20 yrs.) × .25759 (PV of 1, 30yrs) = 7027.2

4. 10 994 (2010) − 8403 (2000) = 2591

   a. 2591 ÷ 10yr = 259.1 × 40.33035 PV of inc ann. 10yr) × .25759 (PV of 1, 30yr) = 2691.7

   b. 2591 × ~~8.47246~~ 7.86431 (PV of ann. of 1/yr, 10yr) × .16390 (P.V of 1, 40yr) = 3339.7

5. 14,345 (2020) − 10,994 (2010) = 3351

   a. 3351 ÷ 10yr = 335.1 × 40.33035 PV of inc ann. 10yr) × .16390 (PV of 1 40yr) = 2215

Sum of above calculations − 3847.5 + 10,973.4 + 3513 + 8896.6 + 3461.5 + 7027.2 + 2691.7 + 3339.7 = 43750.6 × .05163 (amort., 50yr.) = 2259

Factor for 50 yr. evaluation period 3960 (1970) + 2259 = 6219 ÷ 3960 = 1.57

1/ 1969 × 1.09 to convert to 1970 price base

Lower Columbia Water Resource Sub Area No 1713.

Part C

14,345 (2020) − 3960 (1970) = 10,385 × 19.36679 (P.U. gm of 1 per yr, 50 yr.)
× .10429 (PU of 1, 50 yr.) = 20975

Sum of calculations for 100 yr. evaluation period
~~53,34.7~~ 43,750.6 (Part A) + 5334.7 (Part B) + 20,975 (Part C) = 70,060.3

70,060.3 × .04676 = 3276

Factor for 100 yr evaluation period –
3960 (1970) + 3276 = 7236 ÷ 3960 = 1.83

Determine by soil groups, the average production levels to be expected under project conditions.

If the proposed project will not provide adequate water to meet full irrigation needs, determine yields to be expected where the water requirements of the crops are met for only a portion of the crop growing period, as well as for conditions where the full irrigation water requirements are satisfied.

In estimating yields under project conditions, assume moderately high to high levels of management, good fertilizing practices, use of improved crop varieties, and introduction of technological advances.

5. Land Treatment Requirements.

Determine, for each soil group, the kinds of land treatment measures that need to be installed to achieve agreed to irrigation objectives.

Objectives should include use of water at efficiency levels reasonably close to the levels shown in the local irrigation guide (See Watershed Protection Handbook, Part 3, Chapter 3.)

Determine the amounts of each kind of land treatment measure required with each increment of project development. The amounts must be based on a realistic appraisal of the capabilities of the farm operaters and their ability to finance the improvements. However, the amounts should not be less than required to meet agreed upon conservation objectives in the use of soil and water resources.

Amount with project assumed but no increase in acreage due to increased water supplies from structural improvements.

This is for use as a guide in project formulation. It will permit separate evaluation of the economic effect of each proposed improvement measure. It also can be used to emphasize the economic importance of early installation of the land treatment measures.

Amount required with each alternative program of structural improvement.

Determine the rates of application of needed land treatment measures that can be expected to result from a continuation of going programs.

Determine the amount of technical assistance that will be required for the accelerated rate of installation of land treatment measures within the project installation period.

Use work unit, area, or state man-hour factors adjusted as needed to fit specific conditions within the watershed.

6. Unit Net Irrigation Requirements.

Determine monthly consumptive use requirements (acre-inches per acre) for each crop of sufficient importance to be considered in evaluating the project.

Except in Hawaii, consumptive use requirements are to be computed by the Blaney-Criddle procedure modified to include the use of monthly crop coefficients.

Technical Release No. 21, dated April 29, 1964, on "Irrigation Water Requirements" explains the modified Blaney-Criddle procedure and provides information on monthly crop coefficients.

In Hawaii, consumptive use requirements will be estimated from pan evaporation data, using locally developed correlation coefficients.

Determine monthly net irrigation requirements for each of the various crops by adjusting consumptive use requirements for effective growing season precipitation, groundwater contributions, allowable soil moisture depletion, and extra application of water needed for leaching.

Generally, some portion of the normal growing season precipitation can be considered to be effective in meeting consumptive use requirements and thereby reducing the amount of water that must be supplied by irrigation. The technical release on "Irrigation Water Requirements" explains how monthly effective rainfall should be determined.

As effective rainfall is a part of the crop water supply, it usually should be computed for the same percent chance of occurrence as used for the irrigation water supply.

In areas having relatively stable water tables at shallow depths some crops may receive a considerable portion of their consumptive requirements from the capillary fringe above the water table. These groundwater contributions usually are estimated from water delivery records and general observations of irrigation practices in the area.

Where moisture is available during the non-growing season from either precipitation or excess streamflow, some end-of-growing-season soil moisture depletion may be permitted in computing net irrigation requirements. The moisture depletion should not exceed the net depth of water applied in a normal irrigation for the particular crop and soil.

If the quality of the water is such that leaching applications will be needed to prevent excessive salt accumulations, determine the requirements for each crop and add to the consumptive use requirements.

Leaching needs usually can be satisfactorily met by applying the leaching water at times when crop consumptive use requirements are low. If this practice is followed, system capacity requirements are minimized.

The procedure shown in Agriculture Handbook No. 60 should be followed in making estimates of leaching requirements.

Determine the weighted average monthly net irrigation requirements for the existing crop distribution pattern and for any other distribution patterns to be used in project evaluation.

In areas of short late season water supplies it can be expected that some crops normally will be given priority consideration for irrigation. In these cases, "priority" groups should be established, and weighted average monthly net irrigation requirements should be determined separately for each such group.

7. Farm Irrigation Efficiencies.

Determine present level of farm irrigation efficiency.

Use existing records of water delivery and crop acreage, or, if adequate records are not available, select representative sample areas and evaluate water deliveries in relation to crop water needs. (See Watershed Protection Handbook, Part 3, Chapter 3).

Estimate future levels of farm irrigation efficiency.

Level to be expected from the continuation of going programs without a w/s project.

Project level to be expected as a result of an accelerated land treatment program.

Analyze the crops to be grown and the irrigation methods to be used as a basis for estimating expected field efficiency levels. Farm efficiencies, then, can be estimated by adjusting field efficiencies to reflect anticipated on-farm conveyance losses and on-farm reuse of surface runoff.

8. Unit Farm Water Delivery Requirements.

Determine monthly gross farm delivery requirements (acre-inches per acre).

For the existing crop distribution pattern and the present level of farm irrigation efficiency.

For the crop distribution pattern and efficiency level to be expected as a result of the continuation of going programs without a watershed project.

For the crop distribution pattern and efficiency level expected after installation of project accelerated land treatment and structural measures.

9. Conveyance Losses.

Determine magnitude of present losses in irrigation system mains and laterals by analyzing existing flow records and/or by making seepage loss measurements in selected sample reaches of the main and lateral canals.

Compute losses to be expected after installation of proposed project conveyance system improvement measures.

If storage or other water supply improvements are proposed, determine conveyance losses to be expected in the delivery of this additional supply to the farm headgates.

Losses to be expected under present conveyance system conditions.

Losses to be expected with the proposed conveyance system improvements installed.

10. Operation Losses.

Make measurements or analyze existing records to determine magnitude of present losses due to such things as waste flows from

canals or laterals when deliveries exceed demand, and water stored in laterals at the completion of an irrigation.

Estimate the magnitude of operation losses to be expected under project conditions.

11. Water Storage.

Storage capacity required to meet full irrigation demand should be provided unless limited by available watershed yield or by the characteristics of the reservoir site. Technical Release No. 19, "Determination of Storage Requirements to Meet Supply-Demand Relationships" demonstrates general techniques and procedures used to estimate the volume of storage required.

Data required to analyze storage potentials.

Stage-capacity-surface area relationships.

Evaporation rates (monthly evaporation) at reservoir site.

Monthly precipitation at reservoir site.

Soils and geological information concerning the reservoir basin and computations of potential rates of seepage.

Monthly inflow volumes.

Storage capacity to meet full irrigation demand.

Using stage-capacity-surface area relationships developed for the site, assume trial values of total capacity and make reservoir operation studies, considering inflow rates, reservoir outflow requirements, seepage losses, evaporation losses, and direct precipitation gains to determine monthly water balances.

Storage capacity limited by watershed yield.

If the watershed yield is insufficient to satisfy full storage requirements, assume trial values of monthly outflow requirements and make reservoir operation studies to determine the capacity required to utilize the available inflow supply and to determine the quantity of water that will be available for irrigation diversion.

Storage capacity limited by site characteristics.

If the storage capacity is limited by the characteristics of the site (physical and/or economic), assume trial values of monthly outflow requirements and make reservoir operation studies to determine the quantity of water that will be available for irrigation diversion.

12. Water Supply-Water Demand Analyses and Computations of Physical Benefits of Project Measures.

Compute for each month the relationship between available farm headgate water supplies and farm headgate water delivery requirements.

Determine (1) the number of acres that can be provided full season irrigation, and (2) the acreage that can be irrigated only part of the season (one month, two months, etc.)

At the present farm efficiency level.

With the efficiency level that can be anticipated with a continuation of going programs without a project.

With the efficiency level expected as a result of a program of accelerated land treatment.

With an accelerated land treatment program and the installation of proposed project conveyance system improvement measures.

With an accelerated land treatment program and the installation of proposed project storage facilities.

With an accelerated land treatment program plus the installation of conveyance system improvement measures and storage facilities.

13. System Capacity Requirements.

Determine the type of water delivery to be employed in the project, as agreed upon with the sponsoring local organization.

Determine the individual farm turnout capacities needed to meet peak period consumptive use requirements and also be provide stream sizes adequate for efficient and economical application of water.

Compute peak period consumptive use requirements by the procedure given in the paper, "Peak Period Consumptive Use," prepared by Dell G. Shockley and Hyrum J. Woodward for presentation at the ARS-SCS workshop on consumptive use, Phoenix, Arizona, March 6-8, 1962, revised August 1962.

Determine the minimum stream size needed for efficient and economical application of water by adding estimated on-farm conveyance losses to the flow rates required for the irrigation method, or methods, to be used. The stream, also, should be large enough to provide for reasonably efficient utilization of labor.

Compute the capacity requirements for each segment of the project irrigation water conveyance and distribution system.

Start at the lower end of each lateral or sublateral and add requirements for each farm turnout progressively to the upper end of the system.

For a demand type of water delivery, capacities should equal the summation of the turnout requirements up to about 30 turnouts. Canals serving more than 30 turnouts may have capacities less than the total turnout requirements. However, the capacity should be at least equal to 30 times the average turnout requirement plus 70% of the average turnout requirement times the number of turnouts in excess of 30. Also, the capacity must be at least sufficient to satisfy peak period consumptive use requirements.

For a modified demand type of water delivery, capacities generally should be sufficient to satisfy peak period consumptive use requirements plus the flow required for one minimum farm turnout. Capacities somewhat less may be adequate for the downstream segments of laterals serving small areas. However, no segment should have a capacity less than that required for one minimum farm turnout.

For rotation type of water delivery, capacities shall be in increments of the delivery stream, with the number of individuals (acres) in each rotation group not greater than can be served at the peak use rate.

With all types of water delivery, it may be necessary to provide extra capacity for the distribution of flood flows available for part season irrigation. It, also, may be desirable to provide additional capacity to permit an expansion of full season irrigation in those years when extra water is available.

C. COSTS.

1. Land Treatment Meas ,res.

Determine unit cost for each kind of land treatment measure to be installed.

Use local data. Document sources of local costs.

Determine total project cost for land treatment, by categories: total installation cost for each kind of land treatment measure in the going program, cost of technical assistance for the going program, installation cost of measures in the accelerated program, and cost of technical assistance required in accelerating the rate of installation.

If the land treatment requirements are not the same for all increments of project development or alternative programs of improvement, the costs must be determined for each situation.

Determine the average annual cost of the on-farm capital expenditure items in the accelerated land treatment program.

Consider the estimated service life of the treatment measure, and the interest rate available to the farmer.

2. Structural Measures.

Prepare designs in the detail required to develop realistic estimates of costs.

Designs will be based on appropriate engineering surveys, geologic investigations, sedimentation and hydrologic studies, and other pertinent information. When structures are to be located on Federal lands, design criteria of the land administering agency will be met.

Make drawings or sketches as needed to clearly explain designs and facilitate computation of construction quantities.

Compute installation costs of structural measures.

Construction cost will be based on required quantities of each construction item and estimated unit cost for each item, plus an appropriate contingency factor.

Estimate costs for installation services, lands, easements, and rights-of-way, contract administration, and water rights, for each structure or group of interdependent structures.

Document all design and cost assumptions, calculations, and references.

Where irrigation is one purpose in a multiple-purpose structure, an allocation of costs to purpose will be made to determine the portions of the installation cost to be charged to irrigation and to the other purposes.

Amortize the installation cost of the structural measures over the project evaluation period. If the life of a structure is less than the evaluation period, cost of replacement must be computed. A comparable example is given in Chapter 9, page 5, of the Economics Guide.

Estimate the average annual cost of operating and maintaining each structure or group of interdependent structures. Where replacement is a factor, add this cost to arrive at the annual operation, maintenance and replacement cost.

Add the amortized installation cost and the O&M cost to arrive at the average annual cost of the structural measures.

Compute for each increment of project development and for each alternative combination of proposed project improvement measures.

D. PROJECT EVALUATION.

1. Income.

Develop land use and conservation cost and return estimates and compute returns for each level of irrigation water supply under "without project" and "with project" conditions.

Cost and return estimates for "without project" conditions will reflect the production to be expected with the installation of the going program land treatment measures. The costs of these measures will be considered in the budgets in arriving at the returns.

Cost and return estimates for various levels of "with project" conditions will consider the cost of the annually or frequently

recurring practices in the accelerated land treatment program. Cost of accelerated program measures which involve a capital expenditure and have a life of five years or more will not be considered in the budget but will be amortized and handled as associated costs in the determination of irrigation benefits (see D-2). Examples of such measures would be on-farm ditch lining, heavy leveling,etc.

Using present and anticipated future crop distribution patterns, compute the weighted income per acre for areas receiving a full season water supply, areas receiving only part season supplies, and areas not irrigated.

Using the acreages of full and part season irrigation shown in the computations of physical benefits of project measures (see B-12), compute the income for each project situation used in computing physical benefits.

Compute the increase in income resulting from installation of project measures, i.e., the difference in income under "without project" conditions and under "with project" conditions.

In order to provide guidance for project formulation and to indicate the relative importance of each kind of proposed improvement, compute the increase in income resulting from each increment of project development, and the increase accruing to the various alternative combinations of project improvement measures.

Increases should be calculated separately for the accelerated land treatment program and for each type of proposed structural improvement, even though the actual acceleration of installation of land treatment measures is dependent upon some program of structural improvement.

2. <u>Irrigation Benefits.</u>

Compute the benefits to structural measures for each increment of project development and for each alternative combination of project measures.

Benefits from project structural measures for irrigation will be the increase in income as described above resulting from installation of project measures, less the average annual cost of the on-farm capital expenditure items

(associated cost treatment items, see D-1) in the accelerated land treatment program accompanying the structures being considered.

If the use of secondary benefits is applicable, they will be computed and handled according to the procedures prescribed in the Economic Guide and Watershed Planning Handbook.

3. Benefit-Cost Relationships.

Determine the relationship of average annual benefits to average annual costs for each separate increment of project development and for each alternative combination of proposed project improvement measures.

Structural improvements alone.

Compute for each individual structure or group of interdependent structures.

Accelerated land treatment plus structural improvements.

Compute for each individual structure or group of interdependent structures.

Accelerated land treatment plus alternative combinations of structural improvements.

Compute the Benefit-Cost ratios needed for the work plan presentation.

Table 6 of the work plan will show the B:C ratio for the total irrigation development, or for separable segments. For multiple purpose measures, the benefits to other purposes will be included.

SUBJECT: Damages resulting from delayed irrigation water delivery

Computation of damages caused to growing crops from delays in irrigation water delivery have always been difficult to assess. While the losses can usually be ascertained about a particular historical event, projection to future conditions is accompanied by more than the normal amount of projection error. Various factors account for this; i.e. seasonality of the delay, length of delay and the accompanying rainfall over the general area at the time of the break. The overriding condition to development of damage factors associated with delays appears to be that most irrigation canals are susceptible to damage from only the more infrequent events. This often means that historical records only vaguely resemble the present agricultural conditions which exist in the area served by the canal.

Where historical damage figures are not available or where they are so old as to be of questionable value, some procedure has to be developed to determine the amount of these losses. The following procedure uses an average gross income per inch of net irrigation water required. In addition to the monthly net irrigation requirement information is needed on (1) monthly storm distribution, (2) the storm frequency at which loss of the canal can be expected, and (3) the number of days required to restore delivery.

The following example has been developed to show this procedure.

Specific Conditions:

A. Frequency at which canal loss can be expected 6%.

B. Number of days required to repair loss and restore service 15 days.

C. Monthly storm distribution (percent of annual):

January	0	February	1	March	3	April	5

May 22	June 33	July 17	August 10
September 5	October 3	November 1	December 0

Damageable value:

Land use, yield and gross income for the area served by the canal:

Crop	Land Use %	Yield	Price	Return	Composite acre return
Corn Silage	10	20 ton	$ 7.00	$ 140	$ 14.00
Sugar Beets	20	16 ton	15.00	240	48.00
Small Grain	10	50 bushel	1.10	55	5.50
Pasture	20	8 AUM	4.00	32	6.40
Alfalfa	40	5 ton	20.00	100	40.00
Total	100				$ 113.90

Consumptive use requirements minus rainfall by months for the crops of the irrigated area:

Crop 1/	April	May	June	July	August	September
Corn S.		1.52	2.69	4.77	4.65	1.54
S. Beets	2.00	2.44	1.99	4.01	3.95	2.57
Sm. Grain		2.73	2.34	2.20		
Pasture	2.20	2.73	2.34	4.39	4.30	2.82
Alfalfa	2.41	3.03	2.69	4.77	4.65	3.07

1/ Growing season

Alfalfa - April through September

Pasture - April through September

Sugar Beets - April through September

Corn Silage - May 15 to September 15

Small Grain - May to July 15

Composite acre water requirement:

Crop	Land Use	April	May	June	July	August	Sept.	
Corn S.	10		.15	.27	.48	.47	.15	
Sugar B.	20	.40	.49	.40	.80	.79	.51	
Sm. Grain	10		.27	.23	.22			
Pasture	20	.44	.55	.47	.87	.86	.56	
Alfalfa	40	.96	1.21	1.08	1.91	1.86	1.23	
Total	100	1.80	2.67	2.45	4.28	3.98	2.45	17.63

Value added per inch of irrigation water supplied

113.90 ÷ 17.63 = $6.46

Value added per month

April	May	June	July	August	Sept.	Total
$11.63	$17.25	$15.83	$27.65	$25.71	$15.83	$113.90

Value added per day

.39	.56	.53	.89	.83	.53

Damage per composite acre from a 15 day break in:

5.85	8.40	7.95	13.35	12.45	7.95

Weighted damage per composite acre:

Month	Damage		Monthly Storm Distribution		
April	5.85	x	5	=	
May	8.40	x	22	=	
June	7.95	x	33	=	
July	13.35	x	17	=	
August	12.45	x	10	=	
September	7.95	x	5	=	
Total					$ 8.68

This $8.68 is the weighted damage per composite acre per break. The average annual damage from delay in water delivery is equal to number of acres served times damage per acre times the storm frequency required to cause the canal to fail. (This assumes that the breaks from more infrequent storms do not require longer to repair.)

If in the above example this canal serves 1500 acres, the average annual damages would then be:

1500 acres x $8.68 x 6% = $781.20

CHAPTER 8

MUNICIPAL AND INDUSTRIAL WATER SUPPLY

This chapter deals with evaluation of facilities for provision of a municipal or industrial water supply as a part of a small watershed project. The first section describes briefly the responsibilities of the sponsoring organization and the Soil Conservation Service in the evaluation. The remainder of the chapter outlines the analysis needed by the Service to meet its responsibilities.

I. RESPONSIBILITIES IN EVALUATION

A. Sponsoring Organization

When a project includes provision for a municipal or industrial water supply it is necessary that the sponsors furnish an estimate of the benefits to be derived from this segment of the project.

The sponsors in most cases will obtain the services of engineers who will study the water supply needs, the alternative means of meeting these needs, considering both the yield and quality of water supply, estimate the costs, recommend the best solution of the water supply problems, and evaluate the benefits to be expected.

B. Soil Conservation Service

The Soil Conservation Service does not estimate the benefits to be obtained from inclusion of a water supply for municipal or industrial use as a project purpose. It does have the responsibility of checking the estimates made by the local organization to make sure that the estimated benefits are realistic, and to make certain of economic justification if the purpose is included in the project. Although the Service should not require the local organization to use certain evaluation procedures, it should indicate the nature of the tests that it will make to assure that the purpose is worthy of inclusion in the project.

II. ANALYSIS BY THE SERVICE

A. Data Required

1. Data Furnished by the Sponsors

The sponsoring organization is responsible for furnishing most of the data needed to make an evaluation of the feasibility of provisions for municipal and industrial water supply. In order to make such an evaluation, hydrologic and geologic as well as economic data must be furnished.

The water supply needs must be analyzed. This will require an estimate of future needs based on population and water use projections.

The adequacy of the proposed improvement to meet these needs must be determined after consideration of water yield at the site of the improvement and evaporation and seepage losses. Ordinarily a water budget through a critical period will need to be prepared for this determination.

Alternative sources of supply need to be examined to determine the cheapest alternative to the proposed project facility which will provide an equivalent water supply both in quantity and quality. The sponsoring organization will usually furnish the Service with any estimates of the costs of alternatives they may have made.

When provision of a water supply for non-agricultural purposes is included in a multiple-purpose structure, the sponsors will furnish the estimated cost of features of the structure designed specifically for the water supply. They will also provide estimates of the cost of operating and maintaining the water supply facility, including such items as filter plants, pumps, and pipe lines.

Finally, the sponsors will provide an estimate of the municipal and/or industrial water supply benefits that will accrue to the features of the project that are included for this purpose. If recreation is not a purpose of the water supply development, recreational benefits from incidental use of the facility may be claimed for economic justification where recreational use can reasonably be expected to develop. In this case, however, the cost of installing, replacing, operating and maintaining any recreational facilities should be deducted from the incidental recreational benefits. When recreation is also a purpose of the water supply development and Federal project funds are used for installation of the recreational facilities, recreation benefits should not be included with municipal and industrial water supply benefits.

2. Data Accumulated by the Service

The Soil Conservation Service will need to obtain sufficient data to enable it to fulfill its responsibility for checking estimates made by the sponsoring organization. Some of this information will be inherent in the particular facility being studied.

The water yield at the site should be determined with sufficient accuracy to provide reasonable estimates of the supply particularly during critical periods.

Accumulation of information on the water supply needs, and the costs and benefits from water supply developments in other comparable situations, will provide a convenient benchmark for Service appraisal of estimates submitted by the sponsoring organization.

B. Benefit Determination

Municipal and industrial water supply is considered to be economically justified if it supplies water at no greater cost than the cheapest most likely alternative source that would be utilized in the absence of

the project. Where an alternative source is not available or would not be economically feasible, benefits may be estimated on the basis of the average cost of raw water from water supply projects planned or recently constructed in the general area or region. This is not quite the same as if water is considered to be worth what it costs insofar as a given community is concerned. When the cost becomes too high, further development is handicapped. At some point the cost may become so excessive that migration to an area where costs are lower will take place. This is especially true in the case of water for industrial use. Information on costs of water in similar situations elsewhere is helpful in estimating the upper limit of justifiable water costs.

The sponsoring organization's estimate of benefits from the provision of a water supply may include only the benefits from the multiple-purpose development. On the other hand, it may cover the benefits from the entire water supply system, including facilities for storage, purification and distribution. In all cases the Service must ascertain just what is included before it can judge the validity of the estimate. When other than project facilities are included, the cost of providing, operating and maintaining the additional features may be converted to an annual figure and deducted from the water supply benefits as an associated cost.

In areas designated under the Area Redevelopment Act, or under similar circumstances where redevelopment benefits may be claimed, the Service should ascertain if the benefit claimed for water supply development includes additional employment of otherwise underemployed local labor through industrial expansion. When this is the case, if the non-agricultural water management benefits are not adjusted there will be double counting of benefits if redevelopment benefits from this source are claimed.

The possibility of double counting will be avoided if secondary benefits are not claimed in those cases where provision of a municipal or industrial water supply leads to the establishment of an industry for which redevelopment benefits are claimed.

C. Deferred Use of a Municipal or Industrial Water Supply

A watershed project may provide for construction of facilities to meet an anticipated future need of water for municipal or industrial use with repayment deferred until use of the water begins. Here costs are incurred during project installation but water supply benefits will be deferred. Consequently, benefits should be discounted for their lag in accrual. However, if the cheapest justifiable alternative source of supply is used as a measure of benefits, consideration should be given to the cost of the alternative at the time water is needed. Inasmuch as suitable reservoir sites are limited, failure to include the water supply at the time of project installation may require exceedingly heavy expenditures at the time of need.

D. Essentials for Justification of Inclusion of Municipal or Industrial Water Supply in a Project.

Industrial Water Supply in a Project

Two considerations are basic to justification of the inclusion of municipal or industrial water supply in a small watershed project. First, the Service must satisfy itself that the benefits claimed are reasonable and likely to be obtained. Next, the benefits must be equal or greater than the cost of the purpose.

Once the Service is satisfied on these points it is not concerned with detailed studies to determine the exact magnitude of benefits from providing a municipal or industrial water supply.

PRELIMINARY

MAY 28 1975

SUBJECT TO REVISION

CHAPTER 9

RECREATIONAL AND FISH AND WILDLIFE DEVELOPMENT

This chapter describes the evaluation of recreational developments, in conjunction with water resource improvements, both with regard to benefits and the cost of development. The first section discusses the basic methodology for completing projections of potential use with a recreational development as a project purpose. Finally, the evaluation of recreation and fish and wildlife benefits are discussed.

I. ESTIMATING DEMAND AND EVALUATING SUPPLY (Use of Worksheet 1, page 5)

A. Recreation Market Area

The recreation market area (RMA) is generally defined as the area from which 80 percent of the people are drawn on one-day outings, a weekend (overnight trip) or both. About 80 percent of the overall use is oriented to day-use activities with 20 percent devoted to overnight activities. In heavily populated areas, the RMA may constitute an hour's drive or 50 miles. Good roads and lack of alternative recreational opportunities may indicate that the RMA should be extended based upon local conditions and habits of users at other recreational development in the area. On the other hand, topographical features or barriers may determine that the RMA be retracted. The RMA need not conform to a circular or isochron pattern but rather may adhere to county boundaries where data gathering may be simplified. Vacation-type travel requires special consideration in establishing the boundaries of the travel time distance.

When the RMA of one watershed project overlaps another RMA, it is necessary to distribute or relate the population of the area of overlap to the affected watersheds in order to prevent "double counting."

B. RMA Population

Determine the population in RMA for project year 5 (five years after recreation development is in place, or 15 years from planning authorization date). The population for the RMA at this time frame should be derived basically from the following procedure:

1. Check regional water resources studies for best projections. Such regional studies as Type 1, 2 , Level A and Level B basin studies under the Water Resource Council, Type 4 river basin studies, state comprehensive outdoor recreation plans, etc.

2. Check OBERS projections for rural areas and SMSA areas.

3. Check with state and county planning projections.

These above combination of resources would give the best indication of historical data, proposed economic developments, and projected population trends reduced to a common denominator of population projection by RMA.

C. Per Capita Participation Rate (Column 1, Worksheet 1, page 5)

Per capita participation rates (activity occasions) are defined as the number of occasions of participation in an activity by the population in the RMA area. State comprehensive outdoor recreation plans include per capita participation rates by activities. If not, one can compute a per capita rate by dividing use for an activity within an area by the population within that area. Such data can be projected into the future by multiplying the projected population times the per capita participation rates for selected time periods.

D. Activity Demand in RMA (Column 2, Worksheet 1, page 5)

To calculate this figure, multiply time period population of RMA by appropriate activity per capita participation rate of Column 1. Include only those activities judged potentially suitable for the site.

E. Competitive Activities With Other Sites (Column 3)

From existing inventory data, determine potential recreation days for the individual activities provided by existing developments. If not available, use the following formulas:

Picnicking

$$\text{Number of tables} \times \begin{pmatrix}\text{Visitors}\\ \text{per table}\end{pmatrix} \times \begin{pmatrix}\text{Turnover rate } \underline{1}/\\ \text{peak day}\end{pmatrix} \div \begin{pmatrix}\text{Peak day}\\ \text{0.3 week}\end{pmatrix} \underline{2}/ \quad \text{Season} = \text{Activity Occasions}$$

50 tables x 5/table x 2.5 uses ÷ 0.3 x 14 weeks = 29,167 Activity Occasions

Camping

$$\text{Camp sites} \times \begin{pmatrix}\text{Visitors}\\ \text{per site}\end{pmatrix} \times \begin{pmatrix}\text{Turnover rate}\\ \text{peak day}\end{pmatrix} \div \begin{pmatrix}\text{Peak day}\\ \text{0.3 week}\end{pmatrix} \times \text{Season} = \text{Activity Occasions}$$

25 sites x 4/site x 1 ÷ 0.3 x 14 = 4,667 Activity Occasions

1/ Turnover rate is used to measure number times per day that a facility is used by different people. Usually used with picnicking, boating, swimming, etc.

2/ Peak day is the measure period for developing design load of facilities. The period represents expected use on a normal Sunday afternoon during the recreation season. Holidays are excluded as measurement periods for peak days.

Hiking

$$\text{Distance} \times \frac{\text{Visitor}}{\text{mile}} \times \frac{\text{Turnover rate}}{\text{peak day}} \div \frac{\text{Peak day}}{(0.3\ \text{week})} \times \text{Season} = \text{Activity Occasions}$$

$$3\ \text{mile} \times 3/\text{mile} \times \frac{2}{\text{peak day}} \div 0.3 \times 14\ \text{weeks} = 10{,}640\ \text{Activity Occasions}$$

Boating

$$\text{Acres} \times \text{Boats/acre} \times \frac{\text{Turnover rate}}{\text{peak day}} \div \frac{\text{Peak day}}{0.3\ \text{week}} \times \text{Season} = \text{Activity Occasions}$$

$$165 \times 0.6/\text{acre} \times \frac{1}{\text{peak day}} \div 0.3 \times 14\ \text{weeks} = 4{,}620\ \text{Activity Occasions}$$

F. Net Activity Demand for Site (Column 4, Worksheet 1, page 5)

Compute this figure by subtracting the evaluated supply indicated in Column 3 from projected demand shown in Column 2. The difference from this calculation is known as the unmet requirements for the RMA.

The sum of the demand for the individual activities is <u>not</u> to be construed as synonymous with annual recreation days. A user may go picnicking, fishing, and boating all in one day on a single development during the same visit. An estimate of annual recreation days demand may be obtained by dividing total activity occasion demand by a conversion factor of 2.5. (NOTE: It is assumed that the average person participates in 2.5 activities during an average visit to a recreation area. Therefore, 2.5 activity occasions equal one recreation day.) This would then give us the annual recreation day demand which should never be lower than the highest figure in Column 4.

G. Design Load Demand (Column 5)

The number of users that will desire to participate in an activity on a Sunday during the recreation season may be estimated by multiplying the activity demand (Column 4) by 2 percent (2 percent based on the assumption of a 14-week season and that 30 percent of the weekly use will occur on Sunday). Other percentages may be used if greater use occurs on Sunday, or you have a different length of recreation season. This demand information will assist in determining the type and extent of activities desired by the RMA population. In many instances, it is quite possible that demand may exceed the site's resource capacity and capability consequently only part of the demand may be fulfilled by the development as proposed.

II. ESTIMATING NEEDS AND SITE CAPACITY ASSESSMENT (Worksheet 2, page 6)

A. Potential Capacity Per/AC Per/Day (Column 1)

These capacities are based on data from "Outdoor Recreation Space Standards," and "State Outdoor Recreation Plans."1/ WHERE deviations occur, the changes are based on potential conditions and to stress quality planning and use within the carrying capacity of the site for the planned activity. WHEN necessary, the figures will need to be adapted to local needs with regard to state laws and regulations, soils, water productivity, stocking rates, and quality use desired. Daily turnover is included in these figures. These capacities may also be used to determine whether existing and nearby competing areas are being used to capacity or are overused.

B. Design Load Demand (Column 2)

Information for this column is carried over from Column 5, Worksheet 1.

C. Acres Needed (Column 3)

Calculate the acres needed by dividing design load demand (Column 2) by potential capacity per/acre per/day (Column 1). The data obtained is the acres needed to meet the demand for the particular activity on the average Sunday during the heavy use season. In many areas of the West, the acres needed to satisfy demand will exceed the capacity of the site and financial capabilities of the sponsors.

D. Acres Available (Column 4)

This column is used for recording the actual acres available on the site being planned. Considerations are given to complete resource analysis, resource capability, and feasibility.

E. Potential Capacity Available (Column 5)

Calculate by multiplying potential capacity per acre per day (Column 1) by acres available (Column 4).

F. Acres Planned (Column 6)

Acres planned are recorded in this column. Acres planned may be less than acres available (Column 4) when:

1/ Information is available from applicable state outdoor recreation planning agency.

Worksheet 1

ESTIMATING THE DEMAND FOR OUTDOOR RECREATION ACTIVITIES
IN RECREATION DEVELOPMENTS

Project Measure
Watershed _____ Date _____

Site No. _____ County _____ State _____

Projected Population (1980) in Recreation Market Area (RMA) _____

Activity	(1) Days of Participation per Capita (W)	(2) (RMA) x (1) Activity Demand in Recreation Market Area	(3) Competitive Activities on Established Sites	(4) (2) - (3) Net Activity Demand for Site	(5) (4) x 2% 1980 Design Load Demand
		Activ. Occas.	Activ. Occas.	Activ. Occas.	Activ. Occas.

Worksheet 2.

ESTIMATING NEEDS AND POTENTIAL CAPACITY ON A RECREATION DEVELOPMENT

Watershed_____ Date_____

Site No. _____County_____ State_____

Activity	(1) Potential Capacity Ac/Day	(2) 1/ 1980 Design Load Demand	(3) (2)÷(1) 1980 Acres Needed	(4) Acres Avail-able	(5) (1)x(4) Potential Capacity Avail-able	(6) Acres 2/ Planned	(7) (1)x(6) Design 3/ Load Capacity Planned
Fishing Warm water Trout							
Boating							
Swimming							
Camping							
Picnicking							
Hiking							
Nature walks							

A. Daily Design Load Capacity Planned _____

B. Annual Recreation Days (A ÷ 2%) _____

1/ See Column 5 of Worksheet 1.
2/ Indicated "agreed to objective" of sponsors
3/ Reflects "selected plans"

1. Design load (Column 2) and acres needed (Column 3) do not require full development.

2. Monies are not available to sponsors.

3. Sponsors are interested in developing the area in phases or stages.

When all the acres available are planned during the initial development, it will be particularly helpful to future planners if these unplanned areas are so designated. Note: If the predicted demand indicates further development within the decade, waste disposal facilities to handle future needs should be given prime consideration during initial development.

G. Design Capacity Planned (Column 7)

Calculate by multiplying potential capacity per/acre per/day (Column 1) by acres planned (Column 6). A heavy design load demand and a low design capacity planned may indicate that possible deterioration of the site is to be expected because of overuse. Poor fishing, vegetative deterioration, erosion problems, and user dissatisfaction may be the result. The daily capacity should not exceed the sum of Column 7 if quality recreation is to be maintained. On the other hand, a high design capacity planned figure and a low design load demand indicates possible overplanning. For public areas, a slightly higher design capacity may prove fortunate considering the usual conservationism in anticipating future recreation demands.

1. Daily Design Capacity Planned (Column 7)

Turnover use on the area is already anticipated by the figures given in Column 1.

2. Annual Recreation Days

For preliminary planning purposes, the annual recreation days may be calculated by dividing the daily design capacity total (Column 7) by 2 percent. The annual recreation days should be rounded out to the nearest thousand. Greater detail implies a degree of accuracy that does not exist no matter how many factors we considered. Accordingly, if a desired number of annual recreation days is multiplied by the selected factor, such as 2 percent, an approximation of the daily design capacity is thereby obtained.

It is assumed that the planning objective is to provide sufficient facilities to accommodate the use anticipated on the average weekend day during the peak season or the peak month of use. This is known as design load.

Daily design capacity, which is the number of people expected to visit and use an area on a design capacity day, can be translated into facilities.

The methodology for establishing design loads using the above formula offers an indication of the need for a specific level of facility development. Studies show that between 15 to 20 percent of the annual use occurs during the peak month. Other surveys indicate that 50 percent of recreation use during the peak month occurs on weekend days and 50 percent on week days. There are nine weekend days during the average peak month. Therefore, the percent of annual use to be accommodated on a weekend day during the peak month (daily design load) can be figured by dividing the peak month use percentage by two and that quotient by nine.

Design load = Percent of annual use occurring in peak month multiplied by percent of use occurring on weekend days, divided by number of weekend days in peak month.

Example: 17% ÷ 2 = 8.5% ÷ 9 = .95% or 1%

Therefore, sufficient facilities need to be designed to take care of 1 percent of the predicted annual use. Thus, the design load for most water-based recreation areas should be about 1 percent of the annual predicted use. Accordingly, 100 times the design load of 1 percent equals the expected annual use. One must next estimate what proportion of the design load will be day use and what proportion will be overnight use. It should be remembered that day use facilities are also used by those who stay overnight and that not all day users require all facilities. Some day users require only water and sanitation.

Reservoirs within day use travel distance of population centers find that day use runs about 80 percent and overnight use of 20 percent during peak months. At remote areas, the proportion of day users generally decreases and overnight use increases. Since recreationists usually use facilities in groups or parties rather than as individuals, it is necessary to convert recreation days into parties. This is done by dividing the user figure in recreation days by the average size of the party (size of party varies from 2.5 to 4.2 person).

<u>Example Calculation - Overnight Use</u>

Formula:

Annual use (recreation days) multiplied by design capacity percent, multiplied by overnight use percent, divided by party size, equals number of family units required for overnight use.

Example:

Projected Annual Use	100,000 Recreation Days
Design Capacity Factor	1.0 Percent

Overnight Use Factor	20 Percent
Size of Party	4

$$\frac{100,000 \times .010 \times .20}{4} = 50 \text{ family units}$$

At this point the planner can decide how to accommodate is expressed requirement. Such as:

Planned Trailer Park	25
Cabins	10
Tent Camping	15
	50 units

Example Calculation - Day Use

Day use facilities normally include facilities that will also be used by overnighters such as launching ramps, parking, swimming areas, beaches, etc. Party size is usually the same as for overnight use (2.5 to 4.2 persons).

In many activities there is a turnover in the use of facilities, meaning that two or more parties may use the same facility during a day. Turnover factor for picnicking and other short term activities usually ranges from 1.5 to 3.0.

Boaters - Percentage of users who do not require facilities other than launching and parking, water and sanitation. Surveys indicate that generally 30 percent of day users fall into this category.

Picnickers - Of the remaining 70 percent of day users, surveys indicate that 35 percent of these non-boating day users desire tables and grills. Of these 35 percent, half of the group desire standard tables and grills while the other half desire movable tables which can be moved with the fluctuating pool level.

Boat Launching Ramps - Launching ramps should be provided for 30 percent of the combined day and overnight use. Car and boat-trailer parking should be provided on the basis of 50 double-length spaces per lane of launching ramp.

Beach Space - Beach space should be provided for 30 percent of the combined day and overnight use on the basis of 100 square feet per person and a turnover rate of 3.

Parking - Parking should be provided on the basis of a minimum of one space per camp unit, 1.5 spaces per picnic table, and 1 space per party of all other classes of day user (car and trailer spaces for boat ramp users). Party size is usually four per car.

Example - Distributing Day Use Needs

Picnicking - Picnic parties anticipated can be determined by multiplying expected annual use by the percent of use anticipated to be day use and by the percent of annual use expected to occur on the average weekend day during the peak month, and dividing this product by the average party size multiplied by the day use turnover rate.

Projected Annual Use	100,000 Recreation Days
Percent of Total use as Day Use	One Percent
Percent of Annual Use to Occur on Sunday	80 Percent
Average Size of Picnic Party	Four
Day Use Turnover Rate	1.5

$$\frac{100{,}000 \times .010 \times .80}{4 \times 1.5} = 132 \text{ parties}$$

One-third of the day use parties will launch boats and require no more than the water and sanitation facilities at the launching site. One-half of the remainder will picnic along the lakeshore where they fish or picnic in turfed areas.

132 x 33 1/3 = 43 parties without facilities

132 - 43 ÷ 2 = 45 picnic units required

Boat Launching - (50 + 1.5 x 132) parties x .30 = 75 launchings over a four-hour period = 19 launchings per hour at a launching rate of 10 per/lane per/hour = 2 launching lanes required.

Beach Space - Design Load = 1,000 persons for combined day and overnight use.

Percent of Combined Day and Overnight Use	30 Percent
Square Feet of Beach Per User	100
Turnover Rate for Beach Use	3

$$\frac{.30 \times 100}{3} = 100 \text{ persons @ 100 square feet} = 10{,}000 \text{ square feet or about } \tfrac{1}{4} \text{ acre}$$

It should be understood that the preceeding procedure for establishing the design load and breaking this down into use facilities for a reservoir is a method only. The criteria utilized in all instances will remain identical, but factors within the criteria could change materially from reservoirs at low elevations and near population centers to high elevation, remote areas. It is most important that the planner record his basic assumptions, and include all calculations and references used in determining design load, and land and facilities requirements.

H. Definitions

Activity Occasion - Participation by an individual in any one recreation activity during all or any part of a 24-hour period.

Design Load Demand - The maximum number of users that will desire to participate on a Sunday during the peak season or the peak month of use.

Design Load Planned - Facilities required to accommodate level of demand proposed with the project water and related land resources on a peak season weekend use day.

Per Capita Participation Rate - These rates are defined as the number of occasions of participation in an activity by the population in the RMA area within a measured time period.

Recreation Day - A unit of measurement consisting of a visit by one individual to a recreation development or area for recreation purposes during a one-hour time period or all of a 24-hour period. It is assumed generally that the average person participates in 2.5 activities during an average visit to a recreation area. Therefore, 2.5 activity occasions equal one recreation day.

Recreation Market Area - The recreation market area (RMA) is generally defined as the area from which 80 percent of the people are drawn on one-day outings, weekend (overnight trip) or both.

I. Evaluation Procedure for Project Recreation Activities

The Federal Register, Volume 36, No. 245 - Tuesday, December 21, 1971 generally discussed the recreation evaluation procedure to be used on all water projects. To give more definitive guidance to SCS personnel, the following materials have been developed.

Keeping in mind the guideline of the WRC, we must remember that a single unit value will be assigned per recreation day regardless of whether the user engages in one activity or several. The unit recreation day value may, however, reflect both quality of activity, and the degree to which opportunities to engage in a number of activities are provided.

The unit of measure will always be based on the recreation day (a standard use consisting of a visit by one individual to a recreation development or area for recreation purposes during a reasonable portion or all of a 24-hour period).

Type of Recreation Day

General Project Recreation Activities - (A recreation day involving primarily those activities attracting the majority of outdoor recreationists and which in general, require the development and maintenance of convenient access and adequate facilities. This category includes, but is not limited to, most warm water fishing, sightseeing, swimming, picnicking, hiking, most small game hunting, nature studies, tent and trailer camping, marine pier and party boat fishing, water skiing, scuba diving, motor boating, sailing, and canoeing in placid waters). Range of Unit Recreation Day Value: $0.75-$2.25.

Figure 1, page 14, contains present guidelines for determination of unit recreation day vales to be assigned to General Project Recreation Activities. Figure 1 guidelines will give a means of meeting the requirements of the WRC.

As an example: Select appropriate point value from elements of Environmental Quality, Site Modification, Development Scale, and Recreation Experience. After this step, take point values from each of the four judgment factors to find total point value. Next, find appropriate total point value on the following scale to determine associated dollar recreation benefit per recreation day.

Total Point Value	Recreation Benefits ($)
0-5	.75
6-10	.90
11-20	1.05
21-30	1.20
31-40	1.35
41-50	1.50
51-60	1.65
61-70	1.80
71-80	1.95
81-90	2.10
91-100	2.25

I. Evaluation of Fish and Wildlife Developments

This section of the evaluation procedure is primarily concerned with fish and the related recreational use of aquatic species and their habitat. A series of calculations using the best estimate of present and projected use, present and projected productive potential of the aquatic habitat to provide fishing, and present and projected demand for fishing and associated recreation use provides an estimate of the monetary effects. General procedures for estimating the man-days and monetary value are:

Step 1

Estimate present man-days of fishing within the RMA. Several techniques are available to estimate present man-day use, sport harvest, commercial harvest, and the monetary values associated with each. It is important that estimates of present use and potential use associated with each aquatic habitat type are developed for each target year. This will prevent assigning man-day and monetary values beyond the capability of the resources. The most reliable information available should be utilized in estimating present use. This will vary from having actual counts of fishing trips on a fee fishing lake or State lake to knowing very little about the use expended on stream segments or lakes.

The method used in this example compares the habitat-types, aquatic habitat acreages, available man-day use, harvest and harvest rates for each species, human populations, fishing license sales, and other data of a large multicounty area. Comparisons are made based on similar frequency distribution of resources as found within a small planning area.

The multicounty approach permits the use of information tabulated on a county, State, or regional basis. Using this data, the total man-days fishing can be estimated for the multicounty area. Since the acreage of each aquatic habitat-type is known within the planning area (from habitat evaluation), the total acreage of each aquatic habitat-type within the multicounty area can be estimated by applying the same percentage figures obtained from the habitat evaluation. If the planning area is not considered typical or characteristic of the multicounty area, percentage adjustments should be applied to acreages for each habitat-type to derive an acceptable acreage figure. The ideal situation would be to have the exact acreage figure for each aquatic habitat-type in the multicounty area. The exact acreage of each aquatic habitat-type should be obtained from field surveys, maps, and photographs where possible. If an exact estimate is not possible, an estimate of each aquatic habitat acreage should be made.

After estimating (1) the acreage involved for each aquatic habitat-type in the multicounty area and (2) the total man-days expended

Form No. 1

Aquatic Economic Evaluation

Evaluation of existing man-day use and monetary value within the area of project influence

Habitat Unit: _____

Harvest Data

1/ Estimated number of fishermen in multi-county area _____

* Percent of fishermen who fish habitat unit _____

Estimated number of fishermen who fish habitat unit _____

* Man-days per fisherman _____

Estimated number of man-days fishing _____

* Harvest per man-day (pounds) _____

Estimated fish harvest (pounds) _____

Project Area Data

Total project area (acres) _____

Habitat unit involved (acres) _____

Percent of area in habitat unit _____

Multi-County Area Data -- Estimates of Use and Harvest

2/ Total area (acres) _____

3/ Percent of area in habitat unit _____

Estimated habitat unit involved (acres) _____

4/ Estimate of man-days involved _____

4/ Estimate of fish harvested (pounds) _____

Acres of habitat unit per man-day _____

Acres of habitat unit per pound of fish harvested _____

Aquatic Economic Evaluation, Existing Man-Day Use and Monetary Values by Species

Form No. 1

Estimates of Use and Harvest on Project Area

Acres of habitat unit in project area
Acres of multi-county habitat unit per man-day

_____ man-days expended on project area (area of project influence)

Acres of habitat unit in project area
Acres of multi-county habitat unit per pound of fish harvested

_____ Pounds of fish harvested on project area (area of project influence)

Estimate of Monetary Values

_____ man-days on project area

x $_____ per man-day

Value of man-days

NOTE: If commercial fishing is involved, the pounds of fish harvested and monetary value should also be estimated.

1/ State license data.
2/ Data from National Survey of Fishing and Hunting - 1970, page 62
3/ Includes only undeveloped area - towns, reservoirs, and military bases have been omitted.
4/ Estimated to be the same as project area. If other data or personal knowledge of project and other county areas indicate an adjustment is required, this percentage value should be changed to obtain the best estimate of habitat unit acreage in the eight-county area.
Obtained from Harvest Data above.

Aquatic Economic Evaluation, Existing
Man-Day Use and Monetary Values by Species

Form No. 4

AQUATIC ECONOMIC EVALUATION

Summary of Man-Day Use & Monetary Values: _____

Project: Date: _____

Habitat Unit	Present			Present Potential			Future Potential			Best Estimate					
										Initial			Ultimate		
	M-D	$ Rec.	$ Com.	M-D	$ Rec.	$ Com.	M-D	$ Rec.	$ Com.	M-D	$ Rec.	$ Com.	M-D	$ Rec.	

1. "Present" estimates from TEE Form No. 1
2. "Present Potential" estimates from TEE Form No. 2 (present conditions).
3. "Future Potential" estimates from TEE Form No. 2 (future conditions).

- Procedure to select best estimate of "Initial" and "Ultimate" values:

  Initial - Select "Present" estimate unless it exceeds biological productive potential; if so, then select "Present Potential" estimate.

  Ultimate - This selection will depend on the biological productivity potential and future demand for the type of recreation. If no future demand (greater than present demand) is expected, the estimate of "Present" use is selected as best estimate of future use. However, if future demand is expected, then the entire productive potential, or portion required to satisfy demand, should be selected as best estimate of "Ultimate" use and monetary value.

  Note: If habitat loss associated with future developments results in decrease potential to provide recreation; but potential supply is still greater than estimate of "Present" use, the "Present" use values should be selected. Although habitat resource and potential to supply recreation are reduced, remaining supply can still meet demands for particular type of outdoor recreation.

Aquatic Economic Evaluation (Form 4), Best Estimate of Initial and Ultimate Man-Day Use and Monetary Values by Species

fishing in each habitat type, the ratio of aquatic acreage to one man-day of fishing can be calculated.

Since the aquatic habitat acreage is available for the project area (from aquatic habitat evaluation), the acres per man-day ratio can be used to estimate the portion of multicounty fishing that occurred within the project area or study area. This estimated man-day use is then multiplied by the monetary value associated with each species and type of specialized recreation use, in Principles and Standards for Planning, or other. Calculations involved in estimating use and monetary value are made on Aquatic Economic Evaluation (AEE) form 1, page 16.

Estimates of current use obtained from AEE Form 1, page 16 are recorded on AEE Form 4 as the estimate of "Present" use and value. These values represent only a monetary evaluation of consumptive recreational use. The total monetary value of the ecological resource is unquantifiable, at the current state of the art, but the estimate should be a monetary value representing the willingness to pay by fishermen to participate in the outdoor recreation based on the schedule of values listed in the Principles and Standards, or other.

Although the above comparison method does provide an estimate of present project areas for fishing, it does not provide an estimate of the present aquatic habitat biological capability to supply fish for consumptive and nonconsumptive use.

Step 2

Estimate present potential of aquatic habitat to provide man-days of fishing within the area of influence (biological productivity method).

Proper planning area evaluation requires identification of the biological potential (capability) of the resource to provide fishing. The objective of this step is to develop an estimate of maximum fishing use that the habitat can provide, while still assuring a high quality outdoor experience. This is accomplished by using resource information obtained from Dingall-Johnson (Federal Aid) reports, State Fish and Wildlife Plans, National Survey of Fishing and Hunting, field surveys and personal knowledge of the project area.

Biological productivity of the existing resource should be evaluated using AEE Form 2, page 20. These forms require the biological study team to consider acreage of aquatic habitat-types, standing crop data, percent catchable size, sustained harvest percentage, catch per man-day, value per man-day, commercial fishery harvest, and monetary value for any commercial fishery harvest, and monetary value for any commercial fishing involved. Where possible, consider the data on a species basis. The data should reflect the best research or survey information available.

Form No. 2.

AQUATIC ECONOMIC EVALUATION

Evaluation of potential man-day use and monetary value within the area of project influence

Planning Area: _____ Date: _____

Planning Stage: _____

Target Year: _____

Habitat Unit	Annual Habitat Capability							Utilization and Values			
	Productive Area	Standing Crop	Available Crop	Percent Catchable Size	Catchable Crop	Sustained Harvest	Annual Harvest	Catch per Man-day	Annual Use	Value per Man-day	Total Value Man-days
	Acres	Lbs/acre	1,000 Lbs.	%	1,000 Lbs.	%	1,000 Lbs.	Lbs.	1,000 M-D	$	1,000 $

Procedure:

1. Make best assessment of aquatic habitat acreage, standing crop poundage, percent catchable size, sustained harvest percentage, catch per man-day, value per man-day, and then calculate the potential man-days and monetary values associated with each species and/or habitat being evaluated.
   - (a) Multiply column 1 by column 2 to derive column 3
   - (b) Multiply column 3 by column 4 to derive column 5
   - (c) Multiply column 5 by column 6 to derive column 7
   - (d) Divide column 7 by column 8 to derive column 9
   - (e) Multiply column 9 by column 10 to derive column 11
   - (f) Where split harvest exists (sport fishing and commercial fishing) the annual harvest for each type of fishing should be based on actual ratio of harvest. This division of annual harvest should be done prior to calculating potential man-days of sport fishing. To derive value of commercial fishery harvest, multiply column 7 (commercial harvest) by monetary value per pound (modify column 10, "Value per Pound") and record in column 11 (modify column 11, "Total Commercial Value").
2. Man-day and monetary values should be calculated for each aquatic habitat evaluated (stream segments, farm ponds, reservoirs, lakes, etc.) and summarized by species and then transferred to TEE Form 3.

Aquatic Economic Evaluation (Form 2), Potential Man-Day Use and Monetary Values by Species

Form No. 2

AQUATIC ECONOMIC EVALUATION

Evaluation of potential man-day use and monetary value within the area of project influence

Planning Area: _____ Date: _____

Planning Stage: _____

Target Year _____

Habitat Unit	Annual Habitat Capability							Utilization and Values			
	Productive Area	Standing Crop	Available Crop	Percent Catchable Size	Catchable Crop	Sustained Harvest	Annual Harvest	Catch per Man-day	Annual Use	Value per Man-day	Total Value Man-days
	Acres	Lbs/acre	1,000 Lbs.	%	1,000 Lbs.	%	1,000 Lbs.	Lbs.	1,000 M-D	$	1,000 $

Procedure:

1. Make best assessment of aquatic habitat acreage, standing crop poundage, percent catchable size, sustained harvest percentage, catch per man-day, value per man-day, and then calculate the potential man-days and monetary values associated with each species and/or habitat being evaluated.
   - (a) Multiply column 1 by column 2 to derive column 3
   - (b) Multiply column 3 by column 4 to derive column 5
   - (c) Multiply column 5 by column 6 to derive column 7
   - (d) Divide column 7 by column 8 to derive column 9
   - (e) Multiply column 9 by column 10 to derive column 11
   - (f) Where split harvest exists (sport fishing and commercial fishing) the annual harvest for each type of fishing should be based on actual ratio of harvest. This division of annual harvest should be done prior to calculating potential man-days of sport fishing. To derive value of commercial fishery harvest, multiply column 7 (commercial harvest) by monetary value per pound (modify column 10, "Value per Pound") and record in column 11 (modify column 11, "Total Commercial Value").
2. Man-day and monetary values should be calculated for each aquatic habitat evaluated (stream segments farm ponds, reservoirs, lakes, etc.) and summarized by species and then transferred to TEE Form 4

Aquatic Economic Evaluation (Form 2), Potential Man-Day Use and Monetary Values by Species

Separately evaluate each planning area segment being considered (stream habitat within proposed conservation pool, flood pool, upstream habitat, downstream habitat, etc.). Evaluation by planning segments will also assist the study team in making judgments on how stream segments, ponds, lakes, etc., will change under projected aquatic resource changes without any plans and with the NED Plan, the EQ plan, and Multi-Objective Plan. Multi-Objective Plans can be evaluated by utilizing data recorded for these same planning segments from the other plans if the same basic data applies to the plan under review.

After completing the evaluation for each planning segment, the total man-days and monetary value involved for each aquatic habitat-type in the entire area should be summarized and transferred to AEE Form 4, page 18, under "Present Potential." This evaluation should be made for (1) Without Any Plans, and (2) with each alternative plan formulated.

If biological productivity of an aquatic area within a planning segment will not change under an alternative plan the same value assigned to the segment Without Any Plans can be used.

Step 3

Estimate future potential of habitat to provide man-days of fishing within the area of influence (biological productivity method).

The objective of this step is to obtain the best estimate of future man-day use and value that the aquatic habitat can provide under resource changes expected for each target year. This calculation must consider projected land-use and ecosystem changes, water pollution projections, and resulting changes in standing crop of catchable fish. By using AEE Form 2, page 20, the land use and ecosystem changes and water quality projections can be reflected in the aquatic habitat available and standing crop estimates. These data, used with known biological data or the best estimate of each biological factor involved, are then used to calculate an estimate of man-days and monetary values. When the forms are completed, the summary data for man-day use and monetary value are recorded on AEE Form 4, page 18, as "Future Potential." Complete this evaluation for (1) Without Any Plans, and (2) with each alternative plan formulated. If the planning segments are the same from one alternative plan to the next and the estimates of future potential of habitat to provide fishing are the same, the estimates derived for the planning area segments evaluated with the NED, EQ, or Without Any Plans can be used for each alternative plan. If future land-use, ecosystem, or water quality changes are not anticipated, future use on each planning area segment should be considered the same as present potential.

Step 4

Estimate existing and future demand for fishing within the multicounty RMA around the project area.

Form No. 3

Planning Area _____ Date: _____

Target Year: _____

Aquatic Economic Evaluation

Evaluation of fishing demand and supply within the multi-county area.

Habitat Unit: _____

Harvest Data and Fishing Demand

1/ Estimated number of fishermen in multi-county area _____
Percent of fishermen who fish habitat unit _____
Estimated number of fishermen who fish habitat unit _____
Man-days per fisherman _____
Estimated number of man-days (demand) _____

Project Area Data 2/--Estimate of Fishing Potential Without Any Plans

Primary habitat involved (acres) _____
Estimated number of man-days on primary habitat (potential) From Form No. _____
Acres of Primary habitat per man-day _____

Multi-County Area Data --Estimate of Fishing Supply

Total area (acres) _____
Percent of area in primary habitat _____
Estimate of primary habitat (acres) _____

3/ Acres of primary habitat per man-day _____
Estimate of man-days in multi-county area (supply) _____

Comparison of Fishing Demand and Supply

Estimate of fishing demand in multi-county area _____
Estimate of fishing supply in multi-county area _____
Difference (if demand exceeds supply, man-day and monetary benefits from EQ Plan or NED Plan should be assigned up to point where demand is satisfied--if supply exceeds demand, only estimate of present or potential man-day use, whichever is less, should be assigned to EQ Plan or NED Plan) _____

1/ Estimate based on:
* Data from:
2/ From Aquatic Economic Evaluation Form No. _____ for each habitat unit
3/ Obtained from Project Area Data above

Aquatic Economic Evaluation (Form 3), Fishing Demand and Supply by Species

An estimate of present and future demand for each type of fishing can be obtained by using present and projected population data, fishing license sales, survey data concerning trips per season, and preference for fishing in different types of aquatic habitat, and aquatic resources available within the multicounty area. AEE Form 3, page 23, is used to record available survey data and to calculate demand estimates for fishing within a multicounty area. These estimates will be used in selecting best estimate of initial and ultimate use within the area of influence as explained in Step 5.

Step 5

Select best estimate of initial and ultimate man-days of fishing within the areas of influence.

The "Present," "Present Potential," and "Future Potential" use and value estimates as recorded on AEE Form 4, page 18, are used in selecting the "Best Estimate" of use at each target year. By careful review of the use estimates, the most appropriate estimate can be selected as representing the man-day use and monetary value associated with each plan.

If the "Present" estimate is larger than the "Present Potential" estimate, the "Present Potential" estimate should be used as "Initial" use to prevent assigning values in excess of what the resource can provide on a sustained yield.

If the "Initial" estimate is lower than the "Future Potential" estimate and human population projections indicate an increasing future demand for fishing at a target year from Form 3, page 23, then the "Future Potential" estimate, or whatever portion may be needed to meet projected demand should be used as the best estimate of "Ultimate" use. When AEE Form No. 4, page 18, is completed, the average annual use and average annual equivalent monetary value can be calculated.

Step 6

Compute average annual use and average annual equivalent monetary values of consumptive outdoor recreation.

With the estimates of present use, projected use at one or more target years, and the associated monetary values, the average values can be calculated. These calculations will be made for each major type of fishing: stream fishing, pond fishing, reservoir fishing, etc.

From the estimates of present use, initial use and ultimate use by target year, a graph should be developed for each plan depicting the use and monetary value expected for each recreation type over the project life. The graph can then be divided into segments for

calculating average annual use and average annual equivalent value of recreation days, Figure 1, page 14.

Step 7

Develop comparison tables to show effects of each alternative plan compared to Without Any Plans.

Average annual values obtained for each plan are recorded on AEE Form 5, page 26, and each plan is compared to values obtained in the Without Any Plans evaluation. These values are compared and net effects displayed for the plan evaluated in Form 5, page 26. A separate form is prepared for the NED Plan, the EQ Plan, the Recommended Plan, or any other alternative plan and those values are compared to values obtained in the Without Any Plans evaluation.

Step 8

Develop initial, operational, and maintenance costs associated with fish facilities proposed for each alternative plan.

These costs associated with land acquisition, fishery resource development and management, boat launching facilities for fishermen, parking lots, walkways, piers, bridges, etc., should be determined and presented in graph form to show total initial costs, and OM&R costs over the period of analysis. The graph can be divided into segments as discussed in Step 6: and the average annual equivalent cost calculated. The annual cost figures will be presented under the NED account for each plan.

A separate range in values is provided for each class in order that informed judgment may be employed in determining the applicable unit recreation day values for each individual project under study. WHERE CONSIDERED APPROPRIATE, DEPARTURE FROM THE RANGE OF VALUES PROVIDED IS PERMISSIBLE IF A FULL JUSTIFICATION IS GIVEN.

Form No. 5

SUMMARY

Terrestrial-Aquatic Economic Evaluation

Planning Area: _____ **Date:** ____

Recreation	Average Annual Use and Average Annual Equivalent Value					
	Without Any Plan		With NED Plan 1/		Difference	
	Man-Days	Dollars	Man-Days	Dollars	Man-Days	Dollars

1/ NED Plan - With Minimum Pool, Fishery Management, and Adequate Public Access.

Procedure:

Net average annual use and average annual equivalent values to derive effect of implementing plan. Record net values under "Difference" column. Each plan considered (NED, EQ, & Dual Plans) is compared to "Without Any Plan" evaluation to obtain beneficial or detrimental effects associated with plan under consideration.

Aquatic Economic Evaluation (Form 5), Summary Comparison of Average Annual Use and Average Annual Equivalent Values by Recreation Type or Activity for With and Without Plan Conditions

Terrestrial-Aquatic Economic Evaluation

Planning Area _____ Date _____
Planning Stage _____
Recreation Evaluated _____
Average Annual Use _____ Average Annual Equivalent Value _____

Segment Graphs for Calculating Average Annual Use and Average Annual Eqivalent Values for Aquatic Recreation

CHAPTER 9

RECREATIONAL AND FISH AND WILDLIFE DEVELOPMENT

This chapter describes the evaluation of recreational developments, both with regard to benefits and the cost of development. The first section discusses some of the basic data needed for projections of potential use. Then the evaluation of a recreational development as a project purpose is examined. The evaluation of recreational benefits incidental to other project purposes is explored. Finally the evaluation of fish and wildlife benefits is discussed.

The general background of the discussion is that the demand for outdoor water-based recreation will continue to increase.

I. COLLECTION OF BASIC DATA

The economic analysis of a recreational development in a watershed project is fraught with unusual difficulties. Whereas the demand for agricultural products is reasonably proportional to population, the effective demand for recreation is almost equally dependent upon many other factors. Thus projections of demand for recreation require projections of these factors as well as population. Although a considerable body of information is available for major reservoirs, data on recreational use of the size reservoirs that can be developed in small watersheds is scanty.

An analysis of the following factors, to the extent that data on each can be obtained, will provide a basis for making reasonable projections of expected demand.

A. Data from Similar Developments

During the last few years researchers have begun to investigate the use of recreational developments and have published a limited number of bulletins or other descriptions of their findings. These will contain valuable information, but they are likely to be studies of areas that have had considerable recreational development. Consequently they seldom are applicable directly to areas where water-based recreational developments are new.

Most states have state agencies that are associated closely with public recreational developments. These agencies will be glad to collaborate with Service personnel in planning the facilities needed and estimating the potential use of proposed recreational developments. Their help will be invaluable.

The Service also has been collecting information on the use of small reservoirs for recreation. Use of this information will be helpful in estimating recreational potentials.

From whatever source information is gathered, it can be expected that extensive modification will be needed before it can be applied to a given site or project.

B. Projections

The potential use of a recreational development depends upon a number of factors outside the site itself.

An important factor is the population in the area from which the potential users will come. The size of this area will depend upon the size of the development and the facilities associated with it, the presence of other facilities in the area, and accessibility of the development. Probably in most cases the area from which the greatest use can be expected will be limited to a radius of 50 miles or one hour's driving time, whichever is the lesser. Projections of population growth usually are available for general areas, although probably not for the specific area involved. These projections should be considered in determining the possible use of a development. However, the date when the projection was made is important. Increases in population have been so great that many of the projections made before 1950 already are obsolete.

The demand for recreation is related closely to per capita income. As disposable income increases the proportion required to meet the basic needs of mere existence declines. An increasing share is available for recreation and the other amenities of life. Projections of income also are available although usually not for as localized areas as is often the case with population projections. However, adjustments may be made for local areas by considering the relationship that income in such areas bears to the overall income of the general area for which projections are available.

Still a third factor upon which projections are needed is the increase in leisure time. As the work week is shortened, more leisure time is available. As the time needed for necessities such as eating and sleeping will not increase markedly, a greater proportion of off-work hours will be spent in recreation, cultural pursuits, hobbies and the like. Projections of the work week and leisure time probably are less reliable than those for population and income because of unknown factors in automation and other technological advances.

In addition to general projections there are sources of local information which will help in determining recreational trends. Information on some of the following items will be helpful. What has been the trend in similar areas with recreational development in sales of boats, motors and other equipment for water sports? What is the demand for fishing and hunting licenses in the area? How far are local residents traveling to participate in water-based recreation?

C. Competitive Facilities

Estimates of the potential use of proposed recreational facilities

will need to take into account the competition they will meet from other recreational facilities. The types of recreation provided by the project and competing facilities are important considerations here. Some facilities may attract visitors from a distance over a weekend or for a several-day vacation. Others, such as recreational developments in small watersheds, may have their greatest appeal to nearby residents who want to spend two or three hours. For these reasons it seems probable that major reservoirs and the facilities installed in small watersheds may not be markedly competitive.

D. Environmental Factors

Potential use of a recreational development also is geared to environmental factors. A development in a forested or scenic area is likely to have more than normal appeal. This is enhanced if it is in an area already frequented by tourists, and motels and restaurants are already present.

The effect of weather should be taken into account, not only in regard to its effect on type of activities but also its effect on potential days of use within a season.

Accessibility is a prime consideration. This involves not only distances from population centers or highways but the condition of access roads.

II. RECREATION AS A PROJECT PURPOSE

When recreation is a project purpose it is necessary to weigh the benefits against the costs to determine economic justification. Therefore, it is important to measure each within reasonable accuracy.

A. Types and Seasons of Recreation

The ordinary rather small recreational development that can be expected in small watersheds seldom can cater to all types of water-based recreation. Various kinds of recreation are competitive when attempted over the same body of water. An example is water skiing, swimming, and fishing. An essential early step in evaluation will be to determine the types of use for which it is best suited. This will depend upon the features of the project, the specialization in competing facilities, and the customs and habits of people in the user area. Once the principal uses have been determined, the climate will dictate the seasons of use.

B. Analysis of Use

A limitation upon the use that can be made of a recreational development is that which can be sustained without deterioration of the resources.

The potential types and extent of use of the proposed development will be analyzed in accordance with factors outlined in Section I of this chapter. Consideration will be given to

projected increases in demand for recreation over that which exists at the time of planning. If such increase will exceed the capacity for sustained use without deterioration, the capacity will be the limiting factor on the number of visitor-days used for evaluation purposes.

C. Assignment of Unit Values for Recreation

Numerous attempts have been made to measure the monetary value of recreation. These have ranged from assigning to recreation the full value of user expenditures to the development of demand curves. The first assigns a rather fictitious value in that, among other things, expenses for subsistence would have been incurred even had the recreationist remained at home. Development of demand curves for recreation would be time-consuming and impractical for recreation in a small watershed project.

Pending development of universally accepted systems of measurement, the Service has adopted interim values to apply equally to all types of recreation. These relate the value to the extent and quality of the facilities available.

The quantitative unit of measurement for recreation is the visitor-day which is defined as a visit by one person to a recreation site during a day regardless of how long he stays or the kind of recreation he may participate in.

The following guidelines should be used for making appropriate estimates of the value of a visitor-day, except in cases where local conditions dictate a higher value that can be supported with adequate basic data as provided in Section V-E-9 of Senate Document No. 97, or unless specialized recreation as defined in Supplement No. 1 to Senate Document 97 is involved, which may support higher value.

1. Undeveloped Recreation Facilities - Where little, if any, basic facilities, other than access, are provided, a value of $0.50 per visitor-day may be used.

2. Partially Developed Recreational Facilities - Where limited basic facilities are provided, a value of $1.00 per visitor-day may be used. Examples of such facilities include parking areas, picnicking areas with no cooking facilities or tables, and simple fishing and swimming areas.

3. Fully Developed Recreational Facilities - When more extensive facilities are provided, such as parking areas, boating docks, fishing piers, camping, water skiing, overnight cabins, eating places, picnicking areas with tables and cooking facilities, play areas, and other provisions for a wide variety of recreational opportunities, a value of $1.50 per visitor-day may be used. The same value may also be used where all facilities needed for full development of the planned recreational use, or uses are provided.

D. Determination of Benefits

Once the projected use in visitor-day has been determined together with the recreational value per visitor-day compatible with the facilities provided, the eventual annual value will be the product of visitor-days per year multiplied by the value per visitor-day. The

projected intensity of use generally will not be reached until some time after installation of the facilities. Therefore, in determining the average annual benefit creditable to recreation, it will be necessary to discount the flow of benefits for this build-up period.

E. Appraisal of Costs

When recreation is a project purpose, all of the costs of installation, replacement, and operation and maintenance allocated to recreation become project costs to be compared with recreational benefits to determine the economic justification of recreation.

1. Amortization of Installation Costs - The nature of the facilities when recreation is a purpose present some problems in the economic evaluation.

One problem in estimating annual costs arises because most of the basic recreation facilities will have a considerably shorter life than the water supply development. However, Federal funds can share only the original installation costs. Replacement funds must come from other sources. Therefore, it seems desirable that these facilities be amortized over the project life, with funds for replacement incorporated in the annual operation and maintenance allowance. By this device the sponsoring organization can schedule the user charges so that funds for replacement can be obtained.

The following example will illustrate the procedure:

1. Project life - 100 years.
2. Structure installation cost - $117,000.
3. A $10,000 cost item for basic recreation facilities is included which must be replaced after 50 years.

The Average Annual Cost is Computed As follows:

1. Amortize the initial installation cost, $117,000 X .03165 1/, or $3,703.
2. Estimated annual O & M cost for structure - $504.
3. Convert the future replacement cost to a present worth value and amortize over the project evaluation period: $10,000 X .22811 2/ = $2,281.10 X .03165 1/ = $72.20, or $72.
4. Total O & M, including replacement costs, is ($504 + $72) $576.
5. Annual equivalent costs are $3,703 + $576, or $4,279.

2. Operation and Maintenance - In addition to carrying an allowance for replacement of basic facilities, the allowance for ordinary operation and maintenance should be ample. Most of the basic facilities will need considerable maintenance to keep them in a condition that will attract

---

1/ The 100-year amortization factor at 3 percent.

2/ The present value of 1, 50 years hence, at 3 percent interest.

use. Benches, tables, and buildings will need painting; access roads and parking areas cannot be neglected. The grounds cannot be allowed to become unsightly.

Operation of the facilities will require considerable expenditures. In many cases rather intensive fish management may be needed. If heavy use by swimmers is expected, the need for life guards is worthy of consideration. Attendants to preserve order and prevent vandalism may be desirable. If the facilities are fully or partially developed, the cost of utilities may become an item. In some cases it may be desirable to provide for regulation of the water level in the reservoir.

III. INCIDENTAL RECREATIONAL BENEFITS

Experience has shown that floodwater retarding structures, and reservoirs for municipal, industrial, or irrigation water supply may also provide incidental recreational benefits. Such benefits may be evaluated and counted in economic justification, provided public access or use by organized groups is assured.

A. Types of Use

The larger reservoirs for municipal, industrial or irrigation water supply may be used for nearly all types of water-based recreation. A sediment pool of a floodwater retarding structure generally will be used primarily only for two or three types of use because of the competitive nature of the different uses.

B. Determination of Use

In estimating the incidental use for recreation of structures built for other purposes, consideration must be given to limitations posed by size. The surface area of a sediment pool, for example, may be so small that water skiing will be impractical. Furthermore, sediment pool capacities will be depleted through deposition and their usefulness for recreation will decline as their water surface area and depth diminish. Consequently incidental recreation benefits should be calculated on a decreasing annuity after the efficiency of the pool begins to decline. Such benefits will usually cease before the sediment storage capacity is fully depleted.

Another limitation on the use of storage provided for other purposes in meeting recreational needs may be imposed by the primary purpose or the owners. For example, when municipal use is the purpose, health officials are likely to restrict recreational use both as to type of use and the area on which recreational use is permitted. Owners of farmland may prohibit hunting because of hazards to livestock. Prior water rights downstream may mean that sediment pools must be emptied upon demand. Other restrictions may be imposed depending upon the situation.

The incidental use for recreation of structures built for other purposes often will be limited by their accessibility. Even though public

use is permitted, access roads probably will be inferior to those built for access to structures designed for recreation. Such roads likely will not be all-weather roads and their maintenance may be inadequate to support heavy traffic.

All of these factors should be considered in determining the annual use in visitor-day that can reasonably be expected. In no case should the sustained use limits as determined under Section II B be exceeded, even before the utility of the structure for recreation begins to decline.

C. Assignment of Unit Values

The value assigned per visitor-day of use should be related to the recreational facilities provided. The gross value used may be approximately the same as the values suggested in Section II C.

These values cannot be used as an incidental recreational benefit without adjustment. When recreation is a project purpose, the costs of providing recreational facilities are a project cost. Unless recreation is a purpose, there are no project costs assigned to recreation. In the case of incidental recreation, costs will be incurred in providing recreation. These are considered associated costs. Some examples are:

1. The cost of providing, maintaining and replacing basic facilities. As a minimum, the pools probably will be stocked with fish at an expense to the operator, the sponsoring organization, or the State.

2. Personal services required, such as, trash disposal and collection of fees.

3. Still another cost is the risk associated with the use of these structures. When the operator purchases liability insurance, the premiums will measure this cost. If he does not insure, he is carrying the risk himself and the cost would be approximately the same.

D. Determination of Benefits

The associated costs are deducted from the gross value of a visitor-day to determine the net value of a visitor-day of incidental recreation. The number of visitor-days annually multiplied by the net value per visitor-day, properly discounted, constitutes the annual benefit from recreation incidental to other purposes.

IV. FISH AND WILDLIFE BENEFITS

Where measures are included for fish and wildlife enhancement and no recreational use is to be made of the facility, fish and wildlife benefits may be measured in terms of the cost of the cheapest alternative source of obtaining equivalent benefits that would most likely be utilized in the absence of the project.

CHAPTER 10

COST ALLOCATION AND COST SHARING

This chapter discusses in detail, with appropriate illustrations, procedures for cost allocation and cost sharing in connection with the development of watershed work plans. Section I of this chapter deals with cost allocation while Section II deals specifically with cost sharing.

Public Law 566, as amended, authorizes the Secretary "to make allocations of costs to the various purposes, and to show the basis of such allocations." Current Service Policy provides that "where a single work of improvement is planned to serve more than one purpose, an allocation of costs to each of the purposes shall be made and the method or basis of such allocations shall be described in watershed work plans."

It is important that one recognizes and remembers the distinction between cost allocation and cost sharing. Cost allocation pertains to works of improvement serving more than one purpose. It is the process whereby the cost of the structure is divided equitably among the purposes served, with each purpose receiving its fair share of the advantage resulting from the multiple-purpose installation. Cost sharing is the division of the cost allocated to each purpose to the financing agencies or groups involved. In P. L. 566 projects, costs of structural measures are shared between Federal and local funds.

Although either annual equivalent or capital costs can be used in allocations, it is a Service policy to use capital costs.

I. COST ALLOCATION

Procedures for cost allocation are grouped by types of structural measures. These types are: (1) multiple-purpose reservoir type structures, and (2) multiple-purpose channels.

The following describes the basic procedures involved. Ramifications that may be involved for particular purposes are not included as they are subject to policy changes. These variations are outlined in the Handbook and/or covered by Watershed Memorandums.

A. Definition of Terms and Their Use in Cost Allocation.

1. Alternate Cost

The alternate cost for each purpose is defined as the cheapest cost of achieving the same or equivalent benefits in single purpose structures that will accrue to each purpose in the multiple-purpose structure. The least costly alternative single purpose means of providing benefits equivalent to those provided by each purpose in the multiple-purpose structure should be used in cost allocation. The alternative should be real in the sense that it can be built and if built would produce equivalent benefits. It may, however, be entirely different in

physical plan.

2. Separable Cost

The separable cost for each project purpose is the difference between the cost of a multiple-purpose structure and the cost of the structure with that purpose omitted.

In calculating separable costs, each purpose should be treated as if it were the last increment of a multiple-purpose project. This calculation will show the added costs of increased size, changes in design, or other factors that would be necessary to add the purpose to the project.

3. Specific Cost

The specific cost for each project purpose consists of the cost of facilities that exclusively serve only one project purpose. Special outlet works needed for irrigation or municipal water supply, but not needed for flood prevention, is an example of this kind of facility.

All readily identifiable costs of facilities which are clearly for one purpose only should be assigned as specific costs wholly to that purpose in the allocation process. Thus care should be taken to make sure that all specific costs are properly assigned to each purpose.

4. Joint Cost

Joint cost is the difference between the cost of the multiple-purpose structure and the sum of the separable costs for each purpose. When the estimate of separable costs cannot be made or is unduly burdensome to make, joint costs may be considered to be the difference between the multiple-purpose cost and the sum of the specific costs for each purpose.

B. Reservoir-Type Structures

Acceptable cost allocation methods for reservoir-type structures are (1) Use of Facilities Method, (2) Alternative Justifiable Expenditure Method, and (3) Separable Cost-Remaining Benefits Method. Of these, the use of facilities method is the easiest to calculate and is readily understandable by non-technical people. Under current Service policy it is the preferred cost allocation method. Of the other two, the alternative justifiable expenditure method is the preferred method when the cost of making studies necessary to estimate separable costs is excessive.

1. Use of Facilities Method

The use of facilities method has the following steps:

a. Determine the capacity assigned to each purpose. Sediment capacity will be treated as flood prevention capacity when warranted

by the benefits from the alleviation of downstream sediment problems. Otherwise sediment capacity will not be considered in assigning capacity to purposes. Capacity serving more than one purpose will be divided equally among the purposes served.

b. Estimate the specific cost of each purpose.

c. Deduct all specific costs from the total installation cost of the multiple-purpose structure, to determine joint costs.

d. Distribute the joint costs to purposes in proportion to the capacity assigned to each purpose.

e. Add the specific cost to the joint cost (step 2 + Step 4) to determine the total cost allocated to each purpose.

The following is an example of this method:

A reservoir is designed to serve the following purposes: (1) Flood Prevention; (2) Irrigation, and (3) Municipal and Industrial Storage. Two-thousand acre-feet of the 3,500 acre feet for floodwater detention storage will be shared jointly with irrigation. The sediment damage reduction benefits are sufficient to offset the cost of sediment storage.

Estimated Total Installation Cost:

Construction Cost	=	$100,000
Engr. Installation Services	=	35,000
Land, Easements and Rights-of-way	=	30,000
Administration of Contracts	=	2,000
		$167,000

Storage	Capacity Acre-Ft.	CAPACITY BY PURPOSE		
		Flood Prevention	Municipal	Irrigation
For Sediment	500	500		
For Municipal Water	2,000		2,000	
For Flood Prevention	1,500	1,500		
Joint Storage for Flood Prevention and Irrigation	2,000	1,000		1,000
Total Storage	6,000	3,000	2,000	1,000
Percentage	100%	50%	33.3%	16.7%

I T E M	Total Cost	ALLOCATED COST Flood Prevention 50%	Municipal 33.3%	Irrigation 16.7%
Specific Costs				
Extra Municipal Outlet-Construction	$ 3,000		3,000	
Extra Municipal Outlet - Installation Services	900		900	
Extra Irrigation Outlet-Construction	2,000			$ 2,000
Extra Irrigation Outlet - Installation Services	600			600
Joint Costs	160,500	$80,250	$53,447	26,803
(Construction Cost)	(95,000)	(47,500)	(31,635)	(15,865)
(Installation Cost)	(33,500)	(16,750)	(11,156)	(5,594)
(Administration of Contracts)	(2,000)	(1,000)	(666)	(334)
(Rights-of-way)	(30,000)	(15,000)	(10,000)	(5,000)
Total Allocated Cost	$167,000	$80,250	$57,347	$29,403

2. Alternative Justifiable Expenditure Method

(Also called the Specific Costs-Remaining Benefits Method) This method differs from the Separable Costs-Remaining Benefits Method only to the extent that specific costs are used rather than separable costs. The cost allocated to each purpose is equal to the specific cost plus the allocated joint cost.

The Alternative Justifiable Expenditure Method, is illustrated by the following example:

I T E M	Flood Prevention	Municipal Water	Total
1. Benefits	$50,000	$40,000	$90,000
2. Alternate Costs	35,000	40,000	75,000
3. Lesser of 1 & 2	35,000	40,000	75,000
4. Specific Costs	1,000	6,000	7,000
5. Remaining Benefits	34,000	34,000	68,000
6. Allocated Joint Costs	25,500	25,500	51,000
7. Total Allocated Costs	26,500	31,500	$58,000

3. Separable Costs - Remaining Benefits Method

The Separable Costs - Remaining Benefits Method provides for

(1) assigning to each purpose its separable cost, i.e., the added cost of including the purpose in the project; and (2) assigning to each purpose a share of the remaining or residual joint cost in proportion to the remaining benefits, i.e., the benefits (as limited by alternative cost less the separable cost). Thus the method provides for an equitable sharing of the savings from multiple-purpose development among the various purposes included.

It should be noted that the separable costs-remaining benefits method will allocate costs to purposes so that each purpose is economically justified provided that two requirements of project formulation are met:

(a) The overall benefit-cost ratio is favorable.
(b) The cost of adding each purpose as the last increment (separable cost) does not exceed the benefits derived therefrom.

The Separable-Costs-Remaining Benefits Method normally involves the following steps:

(a) Estimate the total installation cost of the multiple purpose structure.
(b) Estimate the benefits for each purpose.
(c) Estimate the alternate cost of achieving the benefits shown in step (b).
(d) Determine the maximum alternative justifiable expenditure for achieving benefits which is equal to the lesser value of steps (b) and (c).
(e) Estimate separable cost for each purpose.
(f) Determining remaining benefits which are equal to the difference between (d) and (e).
(g) Determining remaining benefits which are equal to the difference between the total cost of the multiple-purpose project and the total of the separable costs for all project purposes. The joint cost is then allocated to each purpose in the same proportion as the remaining benefits for all purposes.
(h) Determine total allocated cost for each purpose by adding the separable cost to the allocated joint cost.

The following is an example using the Separable Costs-Remaining Benefits Method:

I T E M	Flood Prevention	Municipal Water	Total
Benefits	$50,000	$40,000	$90,000
Alternate Installation Costs	35,000	40,000	75,000
Separable Installation Costs	18,000	23,000	41,000
Total Installation Costs	-------	-------	$53,000

ITEM	Flood Prevention	Municipal Water	Total
1. Benefits	$50,000	$40,000 1/	$90,000
2. Alternate Costs	35,000	40,000	75,000
3. Lessor 1 & 2	35,000	40,000	75,000
4. Separable Costs	18,000	23,000	41,000
5. Remaining Benefits	17,000	17,000	34,000
6. Allocated Joint Costs	8,500	8,500	17,000
7. Total Allocated Costs	26,500	31,500	58,000

C. Multiple-Purpose Flood Prevention and Drainage Channels

Where floodwater and drainage problems are found in a watershed, the channel system usually will be planned to serve both purposes. However, in some instances, separable parts of a system may serve only a single purpose. Whenever a channel system serves both flood prevention and drainage purposes, costs should be allocated in accordance with one of the following:

1. Multiple-Purpose Parts of a Channel System

(a) First Alternative - This alternative is primarily applicable to flat watersheds in coastal plain or river delta type water problem areas. Under this situation any part of a channel system serving both flood prevention and drainage will be allocated equally to each purpose. This includes all downstream segments that provide outlets for upstream channels serving both purposes, either singly or collectively.

(b) Second Alternative - A variation of the above procedure may be used when the joint flood prevention and drainage problems exists on the wet land in only a portion of the drainage area served by the multiple-purpose channel. When this condition exists a proportion of the cost of channel improvement equal to the ratio of the area of non-wet land to the total area served by the channel shall be allocated to flood prevention and the remainder of the cost shall be allocated equally to flood prevention and drainage. For the purpose of this allocation, any area served by the multiple-purpose channel which now has or may require on-farm drainage ditches or subsurface

1/ Benefits estimated by the sponsoring local organization to be equal to the alternate cost of the municipal storage.

drains will be classed as wet land and will not be included in the area of non-wet land used to determine the ratio of costs allocated to flood prevention. Also, for this computation, any area controlled by structures incorporating floodwater retarding capacity shall not be counted as area served by the channel.

The following example illustrates the wet vs. non-wet procedure:

Step		Item
1.	5,000 acres	= Uncontrolled area served by the multiple-purpose channel.
2.	2,000 acres	= Acres of wet land.
3.	5,000 - 2,000	= 3,000 acres of non-wet land.
4.	$\frac{2,000}{5,000}$	= 40 percent wet land.
5.	$\frac{3,000}{5,000}$	= 60 percent non-wet land.
6.	$100,000	= Cost of multiple-purpose channel.
7.	$100,000 x 40%	= $40,000 - allocated equally $20,000 to drainage and $20,000 to flood prevention.
8.	$100,000 x 60%	= $60,000 allocated to flood prevention.

9. Total allocation: to flood prevention $80,000, to drainage $20,000.

2. Single-Purpose Parts of a Channel System

When allocating the cost of single-purpose parts of a multiple-purpose channel system the separable reaches or appurtenances serving solely flood prevention or drainage needs should be allocated to the purpose served. For example, that portion of the channel improvement which extends above the wet land area would be allocated to flood prevention. The cost of tile drains or the cost of drainage ditches which are not required or designed to carry outside water would be allocated to drainage.

D. Multiple-Purpose Channels Serving Other Purposes

Occasionally, a channel will be planned to convey irrigation or other water supply in addition to serving flood prevention needs. Under these conditions, the allocation of costs to purposes served may be determined on the basis of the comparative capacities of a channel needed for each purpose.

II. COST SHARING

After costs have been allocated to purposes, by one of the previously described acceptable methods, it is then necessary to determine the costs to be borne by either "566" or "Other" funds. Cost-sharing criteria is set by policy and varies by purposes. These criteria are subject to change from time to time; therefore no attempt will be made here to illustrate acceptable divisions of costs. Reference should be made to the Watershed Protection Handbook and related Watershed Memorandums for detailed instructions.

CHAPTER 11

INDIRECT AND INDUCED EFFECTS

This chapter deals with the estimation of indirect and induced effects in project evaluation.

The first part of the chapter is a brief presentation of Input-Output (I-O) and Economic Base (EB) analysis. The remainder of the chapter provides instructions on the use of these methods to estimate indirect and induced effects from water resource development.

I. General

A. Definition

Indirect effects are the increased net returns which result from economic activity stimulated by production, utilization, and disposition of intermediate goods or services created by the projects.

Note: Indirect effects are changes in the net income of those firms which utilize or use the increased goods and services of the project and must not be confused with indirect damages as defined in Chapter 3 of this guide.

Induced effects are increased net returns which result from economic activities stimulated by consumer spending or wages and income earned from direct and indirect activity created by the project.

Indirect and induced effects can be either beneficial or adverse. Project activites which increase the output of goods or services of a sector are considered to have beneficial effects. Those changes which reduce or eliminate the production of a sector are considered to have an adverse effect. As an example, the conversion of a wooded floodplain to agricultural production would have beneficial effects in the agricultural

sector and adverse effects in the forestry sector. Whether the project's indirect and induced effect is beneficial or adverse will depend on the magnitude of change in each sector and the respective sector multiplier. The calculation of these effects will require sector recognition and delineation in determination of direct benefits.

B. Methods for Estimating Indirect and Induced Effects

1. Input-Output Analysis

Business activity in any form generates other business activity, therefore, the value of an industry to an economy is not limited to the output of that industry. Similarly, the value of a watershed project is not limited to the direct output. As farms or business establishments more efficiently utilize a floodplain, as people utilize the recreational opportunities provided, they involve other businesses as suppliers of associated inputs or as processor or distributors of the increased output. Also, as labor and management spend the income earned through these activities for food, housing, recreation equipment, etc. they activiate additional economic activity. The ratio of the total economic activity, generated by this chain of events, to the initial economic activity is the multiplier. Economic activity may be measured in terms of output (in dollars), income or employment to name a few. The ratio of total output to the initial output yields an output multiplier; the ratio of total income to initial income yields an income multiplier; the ratio of total employment to initial employment yields an employment multiplier.

Input-output analysis is one analytical system for estimating these multipliers.

The steps involved in determining multipliers by I-O analysis begin with a transaction table. This table is a record of the financial transactions between groupings of similar type industries (economic sectors), households (wages and profits), government (federal, state, and local), imports into and exports from the geographic region of concern.

A hypothetical transaction table for the input-output model will look thus:

TABLE 1: INTERINDUSTRY TRANSACTIONS TABLE (IN DOLLARS)

INPUT (PURCHASES) ↓ / OUTPUT (SALES) →	SECTOR						
SECTOR	Agri-culture	Manufac-turing	Util-ities	House-hold	Govern-ment	Export	Total
Agriculture	50	175	0	50	50	175	500
Manufacturing	50	400	300	100	50	100	1000
Utilities	100	50	450	500	50	350	1500
Households	200	125	450	0	225	0	1000
Government	25	50	50	150	0	0	275
Imports	75	200	250	150	25	0	700
Total	500	1000	1500	950	400	625	4975

Example Table 1 shows by columns the source of inputs by economic sectors, and by row, the disposition of output to sectors. For the Agricultural sector, as an illustration, it shows that $50 of inputs came from within the Agriculture sector, $50 of inputs came from the Manufacturing sector, $100 of inputs came from the Utilities sector, $200 was spent for

wages or retained for management, $25 was paid to Government as taxes or direct services, and finally $75 was paid for Imported goods or services to firms outside the area. These figures came from the Agriculture sector column of the table.

In addition to the $50 of its own output sold within Agriculture, $175 was sold to Manufacturing, $50 to Households, $50 to Government, and $175 was exported to users outside the area. These figures came from the Agriculture sector row of the table.

The transaction table is in effect a double entry bookkeeping system of the economic activity in the area.

The transaction table has three basic parts: the processing section, the payments section, and the final demand section. Table 1 is presented again with these three sections specified for illustrative purposes. The economic sectors in each section can be seen in the table.

TABLE 1: INTERINDUSTRY TRANSACTION TABLE (IN DOLLARS) SHOWING PROCESSING, FINAL DEMAND AND PAYMENT SECTIONS

	SALES → / PURCHASES ↓	PROCESSING SECTION SECTORS			FINAL DEMAND SECTION			
		AGRIC	MANF	UTIL	HOUSE	GOVT	EXPORT	TOTAL
PROCESSING SECTION	Agriculture	50	175	0	50	50	175	500
	Manufacturing	50	400	300	100	50	100	1000
	Utilities	100	50	450	500	50	350	1500
PAYMENTS SECTION	Household	200	125	450	0	225	0	1000
	Government	25	50	50	150	0	0	275
	Imports	75	200	250	150	25	0	700
	Total	500	1000	1500	950	400	625	4975

The second step of the input-output technique is the calculation of a coefficient matrix. This matrix expresses the inputs per unit of output. Dividing each input (column element) by the total output for the sector will result in the coefficient matrix, Table 2. The purpose of this step is to express the information in the processing section and the household sector of the transaction table, Table 1, in terms of input requirements per unit of output. The necessity for this calculation will be discussed following the introduction of the identity matrix concept.

TABLE 2: COEFFICIENT MATRIX[1/] (CLOSED MODEL)

	Agriculture	Manufacturing	Utilities	Household
Agriculture	.1	.175	0.0	.053
Manufacturing	.1	.4	.2	.105
Utilities	.2	.05	.3	.526
Household	.4	.125	.3	0.0

1/ The coefficient matrix will also be referred to as the A matrix.

The sectors in Table 2 have been limited to those in the Processing section of Table 1, set off by the dashed lines, and the Household sector. Those sectors in the Processing section, within the dashed lines, contain the interindustry relationships and will provide the information required to measure indirect effects in the region. This is referred to as an "open model."

The addition of the Household sector to this group provides information required to measure both the indirect and induced effects. This is referred to as the "closed model."

In our example these four sectors represent that portion of the regional economy which occurs totally within the region. Government payment, government demand, imports and exports involve transactions between this region and the rest of the world. The geographic size of the region will vary from an area just large enough to still have economic structure to a nation or conceivably a grouping of nations. For our purposes, the U.S. will be the largest region considered.

The next step involves subtraction of the A matrix (coefficient matrix) from I matrix (identity matrix). The I matrix contains zeros (0) in all positions except on the diagonal (a_{11}, a_{22}, a_{nn}) which have a value of 1.

EXAMPLE IDENTITY MATRIX

	Agriculture	Manufacturing	Utilities	Household
Agriculture	1	0	0	0
Manufacturing	0	1	0	0
Utilities	0	0	1	0
Household	0	0	0	1

The function of the identity matrix is to introduce a unit of change in the final demand for each sector. Since we are now dealing with a unit of change, it was necessary to convert the transaction table to this same unit base, the coefficient matrix. Subtraction of the coefficient matrix from the identity matrix yields the coefficients for a new set of linear equations which explain the conditions which will exist

in response to the change in final demand. Matrix subtraction involves subtracting corresponding elements and locating the result in the same position in the new matrix.

As with the coefficient matrix, the example table is for the "closed model" (I-A) matrix with the "open model" (I-A) matrix set off by dashed lines.

TABLE 3: (I-A) MATRIX "CLOSED MODEL"

	Agriculture	Manufacturing	Utilities	Household
Agriculture	.9	-.175	0.0	-.053
Manufacturing	-.1	.6	-.2	-.105
Utilities	-.2	-.05	.7	-.526
Household	-.4	-.125	-.3	1.0

Inversion of (I-A) matrix, open model, results in a matrix of direct and indirect requirements per dollar of final demand. Inversion of the (I-A) matrix, closed model, results in a matrix of direct and indirect requirements per dollar of final demand when households are included as a processing sector.1/

1/ The mathematics of matrix inversion will not be elaborated on here. An explanation of the mechanics is available in many math textbooks and basic discussions of Input-Output analysis.

EXAMPLE TABLE 4: DIRECT AND INDIRECT REQUIREMENTS, HOUSEHOLDS EXCLUDED, OPEN MODEL

	Agriculture	Manufacturing	Utilities
Agriculture	1.172	.350	.100
Manufacturing	.315	1.801	.515
Utilities	.357	.229	1.494
Total	1.844	2.380	2.109

TABLE 5: DIRECT AND INDIRECT REQUIREMENTS, HOUSEHOLDS INCLUDED, CLOSED MODEL

	Agriculture	Manufacturing	Utilities	Household
Agriculture	1.320	.454	.232	.240
Manufacturing	.780	2.129	.932	.755
Utilities	1.166	.799	2.220	1.314
Household	.975	.687	.875	1.584
Total 1/	3.266	3.382	3.384	XXXXX

1/ The totals shown on Tables 4 and 5 are output multipliers. Please note that the total figure for Table 5 excludes the figure in the Household row.

The tables of direct and indirect requirements provide the information needed to develop multipliers. Information in Table 4 is the direct and indirect effects of industry interaction within the region and multipliers developed from this are referred to as Type I multipliers. Information on Table 5 is the direct, indirect, and induced effects of both industry and household (consumption) interactions within the region

and multipliers developed from this are referred to as Type II multipliers. The inclusion of households in Table 5 brings in the induced effects of earnings and expenditures of the Household sector.

Output and income multipliers, both Type I and Type II, are available from the information available at this stage.

The output multiplier for each economic sector is the column sum for that sector. The Type I output multiplier for the Agricultural sector is 1.844; for the Manufacturing sector is 2.380; for the Utilities section is 2.109. A Type I multiplier is developed from an open model (Table 4) and measures only the indirect effects of a unit change. The Type II output multiplier for the Agricultural sector is 3.266; for the Manufacturing sector is 3.382; for the Utilities sector is 3.384. A Type II multiplier is developed from a closed model (Table 5), Households included, and measures indirect and induced effects of a unit change.

The Type I income multipliers are the sum of multiplication of the column elements (Table 4) and the corresponding element from the Household row of the coefficient matrix (Table 2) divided by the Household coefficient (Table 2) for the specific sector. Thus, the Type I income multiplier for Agriculture is $[(1.172 \times .4) + (.315 \times .125) + (.357 \times .3)] \div .4 = 1.538$, for Manufacturing is 2.351, for Utilities is 1.842. The Type II income multiplier is developed in the same manner using the elements from the closed model matrix (Table 5). The Type II income multiplier for Agriculture is $[(1.320 \times .4) + (.780 \times .125) + (1.166 \times .3)] \div 4 = 2.438$, for Manufacturing is 5.496, and for Utilities is 2.917. However, since

the output of households is income from wages and management, the household element by sectors from Table 5 is the income change forthcoming as a result of the change in final demand and, therefore, the Type II income multiplier can be determined by dividing the Household sector elements (Table 5) by the Household coefficient (Table 2), i.e., for Agriculture .975 ÷ .4 = 2.438, for Manufacturing .687 ÷ .125 = 5.496, and for Utilities .875 ÷ .3 = 2.917.

The preceding information is summarized in Table 6. In addition the indirect and induced effects multipliers for output and income have been specified for each sector. The indirect effects multiplier is determined by subtracting 1 (the direct effect) from the Type I (direct and indirect effect) multiplier. The induced effect multiplier is determined by subtracting the Type I from the Type II (direct, indirect, and induced effect) multiplier.

TABLE 6: SUMMARY OF MULTIPLIERS AND COMPUTATION OF INDIRECT AND INDUCED EFFECTS BY SECTORS FOR SELECTED MEASURES

	Direct Effect Mult.	Type I Mult.	Indirect Effect Mult.	Type II Mult.	Induced Effect Mult.
OUTPUT:					
Agriculture	1.0	1.844	.844	3.266	1.422
Manufacturing	1.0	2.380	1.380	3.382	1.002
Utilities	1.0	2.109	1.109	3.389	1.275
INCOME:					
Agriculture	1.0	1.538	.538	2.438	.900
Manufacturing	1.0	2.351	1.351	5.496	3.118
Utilities	1.0	1.842	.842	2.917	1.075

Calculation procedures and a discussion of the I-O concept are available in numerous texts. One of the more basic of these is W. H. Miernykis', "Elements of Input-Output Analysis," Random House.

2. Economic Base Analysis - (from Manley)

3. Modifying Existing Input-Output Studies

A method for modifying existing I-O studies for areas with similar economic structure or for synthesizing transaction tables for subareas within existing I-O studies has been developed by Gholam Mustafa and L. L. Jones of Texas A&M University. This procedure along with program for the IBM 360 is presented in Departmental Program and Model Documentation No. 71-4, titled "Regional Input-Output Model Using Location Quotients," published by Texas A&M.

The development of location quotients is used to indicate the degree of self-sufficiency within the area or region of concern with respect to the area of the input-output study. Where the location quotient for a sector exceeds 1 the area is considered self-sufficient; no change is made in the technical coefficients. Where the location quotient for a sector is less than 1 the area is considered to be less than self-sufficient; an adjustment equivalent to the degree of deficiency is made in the technical coefficients. This adjusted coefficient matrix along with the sector output estimates allows development of a tentative transaction table. This procedure leaves exports as a residual and as such it is possible to develop a minus export figure. By treating minus exports as imports, the transaction table can be balanced.

From this balanced transactions table, standard analysis will calculate sector multipliers for both output and income. These multipliers will be used in an identical manner with those developed when an existing I-O study exists for the relevant region of a project.

4. Ten and Ten Method

The effect of increased production of goods and services in stimulating additional economic activity has been realized previously. However, the absence of other procedures, either I-O or E B, required development of an alternate procedure to estimate the indirect and induced effects. These effects were estimated as a percentage of project benefits, to estimate the increased net income of those who utilize or procedd the project goods or services, plus a percentage of the associated cost, as an estimate of the increased net income of those providing the added factor of production.

In practice, these effects will be considered to amount to ten percent of direct benefits plus ten percent of the increased associated costs and O&M cost necessary to achieve the direct benefits.

It is anticipated this procedure will be used on preliminary investigations, watershed investigation reports, and on projects whose size is inadequate to warrant the time associated with procedures involving greater detail.

C. Zone of Influence

Indirect and induced effects of a project are the product of increased production and the size of the multiplier.

As the size of the region increases, the complexity of the economic structure within the region and the trade between sectors increases. The effect of this is to reduce the dependency of the area on imports and, consequently, for an increased multiplier effect.

On the other hand, as the size of the region considered increases the possibility of production increases in the project area displacing similar production activity elsewhere in the region increases. From the national point of view, this would result in a transfer rather than in increased production of goods or services.

Therefore, while the multiplier effect is greatest at the national level, until a more precise method is available for determining which project outputs are transfers and which are increases in the national output, multiplier effects will be determined only for the region.

II. Effects

As with all other effects analysis, the base for indirect and induced effects is the without and with project approach. The excess indirect and induced effects which will take place in the region with the project over these same effects that could be expected in the future in the absence of the project are beneficial effects. If such an excess does not exist, the adverse effect will be shown. While these effects will be determined by sectors, whenever possible, the combined result will be shown in the work plan.

The calculation of these benefits will be based on I-O studies whenever possible. In the absence of I-O information the E B or a modified I-O approach will be used. In those instances where the intensity of the

investigation or the installation cost of the measure does not warrant the time associated with I-O or EB the Ten and Ten will be used.

Unit economists are in a position to recommend evaluation approaches and to provide information on available I-O studies or on data requirements and availability for other procedures.

These effects are attributed to the project only if it can be shown that there will be an increase in the net income in the supporting economic sectors as a result of the project.

A. Application

Certain features of Input-Output or Economic Base models dictate the way in which these multipliers can be used. Concepts which must be kept in mind are: (1) the transaction table is a record of cost transactions for a specific period of time, usually a year, and as such is static; (2) it accounts for all inputs used in the processing sectors including imports and payments to local, state, and national government units; (3) it is a form of double entry accounting system and, therefore, requires the total input equal total output; (4) the combination of inputs used in production is fixed and constant; (5) change is introduced into the analysis only through the final demand sectors.

The combined effect of these conditions will require the following adjustments in the project benefits before indirect and induced effects can be calculated.

1. Benefits which result from changes in the comsumption pattern of the household or other demand sectors do not stimulate indirect or induced effects. These are damage reductions to residence, business, roads

and bridges where the elimination of the flood hazard does not result in an increased output and recreation benefits realized by residents of the region. Recreation benefits realized by residents of the region are considered as a shift in the consumption pattern of these residents. However, if the development provides a recreational experience unique to the region, it can be assumed that the use of the facility will eliminate the need for region residents to import into the region this type of recreational experience. This import reduction will generate indirect and induced effects. An example of this type of exception would be water storage with facilities for water skiing in an area that previously had only streams. In this instance, the scenic value of the lake may also be unique.

2. Benefits which are primarily esthetic in nature (recreation) to which simulated values are attached to enable reflection in monetary terms and benefits which are evaluated as the cost of the least costly alternative (M&I water) do not meet the basic conditions of I-O or EB. However, to enable determination of generated effects known to occur as a result of recreation and industrial water use, the benefits as calculated will be used as the base for estimating the indirect and induced effects. No indirect or induced effects will be considered for municipal water.

3. Benefit-cost analysis takes special care to keep benefits and costs separate whereas input-output and economic base considers them simultaneously. All benefit categories will be adjusted to determine net benefits relevant to the region of concern. Regional net benefits are determined by subtracting the annual equivalent of local share of the installation cost plus OM&R for a purpose from the benefits for that purpose.

4. The evaluation of the agricultural aspects of many watershed projects has stopped with crop production, even though it is known that the crops are intermediate to livestock production on the farms or ranches in the watershed. Where these situations exist, the value of product actually sold from the farm should be established.

5. The transaction table is a short term static record of past economic activity in an area. Therefore, where a watershed project is expected to cause a major change in the production inputs care must be exercised in using multipliers developed from historical relationships. The development of irrigation in a region where the existing agriculture is all or nearly all dryland would result in a situation where the change in technical coefficients would be of sufficient importance to prevent the unrestricted use of agricultural multiplier developed from historical information.

After the project benefits have been adjusted to conform to the requirements imposed by input-output and economic base, the indirect and induced benefits are calculated by using the factor for the particular sector in which the benefits originate. The Service sector is to be used to determine indirect and induced effects of recreation and fish and wildlife purposes.

B. Project Examples

1. Evaluation with I-O Model

The use of the concepts outlined earlier in this chapter are shown with a watershed example. Tables 2A, 5, and 6 were taken from the work plan. It was necessary to develop additional tables to show the local share of the annual equivalent of the installation cost and the OM&R by purpose.

Multipliers for this region are shown in Table 1E.

TABLE 1E: REGIONAL INDIRECT AND INDUCED INCOME EFFECTS MULTIPLIERS

	Regional	
	Indirect	Induced
Agriculture	.528	.891
Services	.070	.624

WORK PLAN TABLE 2A: COST ALLOCATION AND COST SHARING SUMMARY
MIDDLE CREEK WATERSHED
(DOLLARS)

ITEM	PURPOSE				TOTAL
	FLOOD PREVENTION	AG. WATER MANAGEMENT	RECREATION	FISH AND WILDLIFE	
Multipurpose Structure	360,500	240,000	249,000	23,500	873,000
Irrigation Diversion		19,000			19,000
Recreational Facilities			60,000		60,000
Total	360,500	259,000	309,000	23,500	952,000
PL-566 Funds	355,000	151,000	162,000	14,000	682,000
Other Funds	5,500	108,000	147,000	9,500	270,000
Total	360,500	259,000	309,000	23,500	952,000

WORK PLAN TABLE 5: ESTIMATED AVERAGE ANNUAL
FLOOD DAMAGE REDUCTION BENEFITS
MIDDLE CREEK WATERSHED
(DOLLARS)

Item	Est. Ave. Annual Damage Without Project	Est. Ave. Annual Damage With Project	Damage Reduction Benefits
Floodwater & Sediment Damages			
Crop and Pasture	3,340	100	3,240
Other Agriculture	3,225	75	3,150
Nonagriculture			
Residential	1,450	0	1,450
Road and Bridge	300	0	300
Golf Course	8,050	450	7,600
Subtotal	16,365	625	15,740
Indirect	300	0	300
Total	16,665	625	16,040

WORK PLAN TABLE 6: COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES
MIDDLE CREEK WATERSHED
(DOLLARS)

	AVERAGE ANNUAL BENEFITS							
	Flood Prevention		Ag. Water Mgt.	Non-Ag. Water Mgt.		Secondary		
Evaluation Unit	Damage Reduction	More Intensive Land Use		Recreation	Fish & Wildlife		Average Annual Cost	Benefit Cost Ratio
Multipurpose Project	16,040	2,750	57,000	58,000	1,725	18,500	65,060	2.4:1

TABLE 2E: ESTIMATED AVERAGE ANNUAL OPERATION, MAINTENANCE AND REPLACEMENT COSTS, LOCAL SHARE OF INSTALLATION COSTS AND TOTAL LOCAL COST BY PURPOSE (DOLLARS)

Structure	Flood Prevention	Irrigation	Recreation	F&WL
Multipurpose Reservoir	162	2,650	1,788	
Irrigation Diversion		100		
Recreation Facilities			12,400	
Total OM&R	162	2,750	14,188	
Local Share Installation	275	5,440	7,405	480
Total Local Cost	437	8,190	21,590	480

Adjustment of the benefits shown in the work plan tables is necessary to meet the conditions outlined in Section II, A, Application. These adjustments are:

a. Flood damage reductions which will generate indirect and induced effects in the region are those which result in the increased production of goods and services. To delineate these damage reductions from the totals shown in Table 5, a revised table, Table 3E, has been prepared. This new table also includes, by subclasses, a pro-rata share of the local cost.

TABLE 3E: ADJUSTED ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS AND PRO-RATA LOCAL COSTS

Item	Amount Reduction Benefits	Amount Benefit from Increased Output	Local Cost
Floodwater and Sediment Damages			
Crop and Pasture	3,240	3,240	75
Other Agriculture			
Fences, Buildings	1,525		35
Stored Crops, Livestock	1,625	1,625	38
Nonagriculture			
Residential	1,450		34
Road and Bridge	300		7
Golf Course	7,600		177
Indirect	300		7
Total	16,040	4,865	373 1/

1/ The remaining $64 of local cost is assigned to More Intensive Land Use benefits.

b. Recreation benefits are adjusted, in this example, by subtracting from the total that part which is realized by residents. Since all local costs are borne by residents of the region, no further adjustment is required. Fish and wildlife benefits have been considered as resident realized.

c. Agricultural water management benefits are adjusted by subtracting the local share of the cost allocated to AWM plus OM&R. As a result of this adjustment AWM benefits amount to $48,810.

TABLE 4E: ADJUSTED BENEFITS BY SECTOR FOR COMPUTATION OF REGIONAL INDIRECT AND INDUCED EFFECTS

Item	Work Plan Benefit	Local Cost	Sector Agriculture	Sector Service
Crop and Pasture	3,240	75	3,165	
Other Agriculture	1,625	38	1,587	
More Intensive Land Use	2,750	64	2,686	
Agriculture Water Management	57,000	8,190	48,810	
Recreation				
Non-Resident	28,000			28,000
Total	92,615	8,367	56,248	28,000

Table 5E is a summary of the regional indirect and induced benefits. The adjusted benefit figures come from Table 4E and the multiplier effect factors come from Table 1E.

TABLE 5E: INDIRECT AND INDUCED BENEFITS

Sector	Adjusted Benefits	Indirect Effect Factor	Indirect Effect	Induced Effect Factor	Induced Effect
Agriculture	56,248	.528	29,699	.891	50,117
Service					
(Recreation)	28,000	.070	1,960	.624	17,472
Total	XXXXXX	XXXX	31,659	XXXX	67,589

A revised Table 6 is shown which has combined the indirect and induced effects into an External Effects column.

REVISED TABLE 6: COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES
MIDDLE CREEK WATERSHED
(DOLLARS)

	AVERAGE ANNUAL BENEFITS							
	Flood Prevention		Ag. Water Mgt.	Non-Ag. Water Mgt.		External Effects		
Evaluation Unit	Damage Reduction	More Intensive Land Use		Recreation	Fish & Wildlife		Average Annual Cost	Benefit Cost Ratio
Regional:								
Multipurpose								
Project	16,040	2,750	57,000	58,000	1,725	99,250	65,060	3.6:1

NATIONAL MULTIPLIERS

	DIRECT	TYPE I	INDIRECT	TYPE II	INDUCED
AGRICULTURE					
Output	1.0	2.203	1.203	4.509	2.306
Income	1.0	2.129	1.129	4.395	2.266
MINING					
Output	1.0	1.581	.581	2.756	1.175
Income	1.0	1.920	.920	3.965	2.045
CONSTRUCTION					
Output	1.0	2.015	1.015	3.747	1.732
Income	1.0	2.102	1.102	4.339	2.237
MANUFACTURING					
Output	1.0	2.208	1.208	3.917	1.709
Income	1.0	2.606	1.606	5.380	2.774
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES					
Output	1.0	1.496	.496	3.121	1.625
Income	1.0	1.445	.445	2.985	1.540
WHOLESALE AND RETAIL TRADE					
Output	1.0	1.416	.416	3.425	2.009
Income	1.0	1.289	.289	2.660	1.371
FINANCE, INSURANCE AND REAL ESTATE					
Output	1.0	1.482	.482	3.201	1.719
Income	1.0	1.424	.424	2.940	1.516
SERVICES					
Output	1.0	1.723	.723	3.878	2.155
Income	1.0	1.473	.473	3.040	1.567

The information in this table was developed from Technical Bulletin No. 1421, Economic Research Service, authors are Robert H. Elrod and Preston E. LaFerney

A local multiplier may be used if it fits.

CHAPTER 11

SECONDARY BENEFITS

This chapter deals with secondary benefits as they apply to project evaluation. The first part of the chapter defines and sets forth the derivation of "stemming from" and "induced by" benefits. Also included is a brief analysis of the significance of secondary benefits as they apply to larger areas of consideration than the watershed boundary. Suggested evaluation procedures are outlined in the second part of the chapter.

I. GENERAL

A. Definition

Secondary benefits are the values added over and above the immediate products or services of the project as a result of activities "stemming from" or "induced by" the project.

B. Theory of Derivation

1. Increased Production

Benefits "stemming from" the project arise from the increased production of goods (primary benefits) afforded by the project. With this increased supply of goods, new demands are placed upon the transporting, processing and marketing industries of the project area. Profits realized by these enterprises from handling these new goods are "stemming from" benefits. Take wheat for example, the net profits to a commercial trucker in hauling the wheat from the farm to a local grain elevator, to the elevator operator from his increased business, and to the transporter from shipping the wheat from the local elevator to a primary terminal elevator located outside the watershed are "stemming from" secondary benefits. Production of goods as used here need not be limited to agriculture but may include other forms of production of goods and services such as recreation, etc.

2. Added Purchases

Benefits "induced by" the project arise from increased expenditures by people of the project area. These benefits result from the supplying of additional materials and services required to make possible the increased net returns which stem from the installation of the project facilities. An example would be the increased net income of a fertilizer and seed dealer from sales of additional fertilizer and/or seed to the producers of the project area. Likewise, "induced by" secondary benefits would incur to service stations, hotels and motels, grocery stores and other establishments that supply goods and services to those enjoying recreational or fish and wildlife developments of the project. These

increased expenditures need not be limited to the primary producers. For example, the fertilizer and seed dealer may in turn purchase additional consumer items from his increased net returns, thereby setting up a multiplier effect of "induced by" benefits.

C. Zones of Influence

The significance of secondary benefits varies by zones of consideration. From a local viewpoint, secondary benefits are quite significant when the increased products are processed and marketed within the project area. This economic effect lessens as one broadens the analysis to a state or regional viewpoint and becomes almost nil from a national point of view. Under the latter analysis and under the assumption of a continuously expanding economy, it would be expected that other uses would be available for the resources required by the project and purchases made by people of the project area would bid these production goods away from the other uses in the economy. For these reasons, secondary benefits from a national viewpoint are not considered pertinent to the economic evaluation of P. L. 566 projects.

1. Limitation

In keeping with the above thought, secondary benefits to be used for project justification are limited to those project goods and services accruing within the watershed, and those accruing outside the watershed, that are readily identifiable.

II. BENEFITS

As with all other benefit analyses the base for computing secondary benefits is the "with" and "without" project approach. Secondary benefits cannot be attributed to the project unless it can be shown that there is an increase in net income in secondary activities as a result of the project as compared with conditions to be expected in the absence of the project.

The computation of secondary benefits "stemming from" or "induced by" project measures requires vigorous economic analyses. This involves the collection of such data as normal percent profit for activity, such as transportation to local market, processing or handling by the local market, wholesaler, retailer, where sold to local consumers, and shipping of unprocessed or partially processed commodities to primary wholesale markets outside the project. At the minimum, considerable time and effort would be involved in obtaining local data and computing net values by activities.

In lieu of the time and effort involved in making separate calculations by activities, it is permissible and preferable to use the following factors on an interim basis in determining secondary benefits. The values, as obtained, are net benefits and do not require any deductions of costs that may be incurred in achieving these values.

1. The value of local secondary benefits "stemming from" the project can be considered to be equal to ten (10) percent of the direct primary benefits. Indirect benefits and benefits from the reduction of erosion damages that are based on the capitalized value of loss in expected production, as outlined in Section II A of Chapter 5 of this guide, will be excluded from consideration in computing "stemming from" benefits. The capitalized value arrived at by this procedure has built into its computation the interest of secondary beneficiaries from sustained production in the problem areas.

2. The value of local secondary benefits "induced by" the project can be considered to equal ten (10) percent of the increased costs that primary producers will incur in connection with increased or sustained production. Any cash variable costs that would be sustained in areas of erosion damage (following the procedure outlined in Section II A of Chapter 5) would give rise to "induced by" benefits.

A. Application.

Direct primary benefits as used in computing "stemming from" benefits can be considered as equal to the total primary benefits of the project which may include (1) damage reduction benefits exclusive of indirect benefits and erosion damage reduction benefits computed under the procudure in Section II A of Chapter 5, (2) more intensive land use benefits, (3) changed land use benefits, (4) agricultural water management benefits, (5) recreation benefits, (6) fish and wildlife benefits, and (7) benefits from municipal and industrial water supply.

Caution should be exercised in using benefits from municipal and industrial water supply as the sponsor's estimate may already include a value for increased net returns to secondary beneficiaries.

Increased costs that primary producers might incur in connection with increased or sustained production that gives rise to "induced by" benefits normally will fall into the following categories: (1) any sustained cash variable costs from preventing permanent land damage; (2) associated costs incurred in enhancement benefits on agricultural land, including agricultural water management benefits; (3) project operation and maintenance costs that are necessary to achieve primary project benefits, i.e., basic recreational facilities; and (4) any other costs, including wages used to determine redevelopment benefits, directly associated with marketing or using project goods or services, as for example, a city water filtration plant to use project produced water supply, concession stands and/or moorages associated with recreational developments.

B. Examples

Examples of secondary benefits that may accrue from increased or sustained agricultural production are:

1. Profits of local wholesalers and retailers from handling

increased sales of project produced products consumed locally without processing.

2. Profits of all other enterprises between the place of production and the final consumer, from handling, processing and marketing increased sales of farm products used locally and the transporting, marketing and processing cost of unprocessed or partially processed products to the first normally used wholesale market outside the watershed.

3. Profits from supplying increased goods and services used in production.

Benefits from other forms of production would be similar in nature to those listed above for agricultural production.

C. Secondary losses

An analysis of the secondary effects of a project must take into account secondary losses as well as gains. For example, where projects include facilities for storing water the loss of production in pool areas may be significant. If so, these primary losses will give rise to secondary losses. These will include both "stemming from" and "induced by" effects. These should be evaluated by applying the same percent factors as used in estimating secondary benefits and the resulting losses deducted from the gains to obtain a net secondary effect.

B. Externalities

1. Irrigation

For convenience, the direct benefits from more intensive land use and other conservation systems were included with irrigation.

Benefits:

$ 20,160	Flood prevention
192,400	Irrigation
6,850	Other conservation systems
$219,410	
-2,960	Flood prevention benefits from road, bridge, and other agriculture (Draft Chapter 11)
$216,450	

Costs:

$1,390,000	Total project installation cost
-26,250	Specific cost for recreation facilities
$1,363,750	Installation cost to achieve flood prevention and irrigation benefits

$1,363,750 x .05526 (5 1/2%, 100 yrs.) = $75,360

Project Administration:

$$\frac{\$1,363,750}{\$1,390,000} = \frac{x}{\$199,900}$$ project admin. for total project

x = $196,125
$196,125 x .05526 = $10,838

O&M:

$14,200	Table 4, work plan
-2,020	Rec. developments, Table 4
$12,180	
-7,170	Work plan estimate for ditch rider
$ 5,010	Work plan estimate for reservoir

$$\frac{\$\ 850,000^{1/}}{\$1,181,320^{2/}} = \frac{x}{\$5,010}$$

x = $3,600 estimated O&M for NED multi-purpose reservoir

1/ estimated construction cost for NED plan (11,480 ac. ft.)

2/ Table 1, construction cost

Total cost

$75,360	
10,838	
14,120	
$100,318	

3660 Rec. Bldg.
4470 Bldg.
1800 Water
1550 L.T.
14120

Benefits = $216,450
Costs = 100,318
$116,132
3.395 1/ (indirect & induced)
$394,300

1/ Type II national income multiplier for agriculture, page 11, Draft Chapter 11

C. Utilization of unemployed resources

1. Hired labor

$47,400 estimate made from crop and livestock budgets of increased hired farm labor with project ($47,400 ÷ 11,200 ac. = $4.23/ac.)

$\frac{47,400}{20 \text{ yrs.}}$ = 146.35668 x .05526 = $19,200

2. Recreation service sector

$35,500 Recreation benefits
.05 Assumed 5% of users are non-residents to the state
$ 1,775 Recreation benefits to non-residents

$1,775 ÷ $1,175 (PO-5) = 1.51 man years employment
1.51 x $5,000 (assumed ave. wages) = $7,550
$\frac{\$7,550}{20 \text{ years}}$ x 146.35668 x .05526 = $3,050

3. Project construction and OM&R

$850,000 estimated construction cost for reservoir
$850,000 x .30 1/ x .20 2/ = $51,000
$51,000 x .05526 = $2,800

1/ Assumed 30% of construction to be labor
2/ Assumed 20% of labor requirements as unskilled

Canals & recreation facilities

$242,580 Construction costs for canals (Table 1, Work Plan)
18,890 Construction costs for Rec. Facilities (Table 1, Work Plan)
$261,470 x .30 x .20 x .05526 = $860

OM&R

$ 3,600 Reservoir
2,020 Rec. facilities
7,170 Ditch rider
1,800 Wells
$14,600 x .50 (assumed labor input = $7,300

$\frac{\$7,300}{20 \text{ yrs.}}$ x 146.35668 x .05526 = $3,000

$2,800 + 860 + 3,000 = $6,500

4. Land Treatment measures

$572,620 Table 1, work plan

$\frac{\$88,120^{1/}}{94,190^{2/}} = \frac{x}{\$572,620}$ x = $535,700 est. accelerated land land treatment, NED plan

1/ Accelerated technical assistance, Table 1, Work Plan
2/ Total technical assistance, Table 1, Work Plan

$\frac{\$535,700}{10 \text{ years}}$ x .30 x .50[1/] x 7.53763 x .05526 = $3,300

1/ Assumed 50% of labor input as unskilled

O&M

$535,700 x .025[1/] x .50[2/] = $6,700

1/ O&M estimated at 2.5% of construction cost
2/ Estimated labor

As labor would be performed primarily by the farm operator and his family with an assumed zero opportunity cost, the effects were not discounted.

$3,300 + 6,700 = $10,000

II. NED Account (Adverse Effects)

A. Resources required

Project construction

$1,390,000 x .05526 = $76,810

Project administration

$$\frac{\$259,700 \text{ proj. adm., Table 2}}{\$1,805,790 \text{ instal. cost, Table 2}} = \frac{x}{\$1,390,000 \text{ instal. cost, NED}}$$

x = $199,900 x .05526 = $11,050 ($11,000)

OM&R

$ 3,600	Reservoir
$ 2,020	Recreation facilities
$ 7,170	Ditch rider
$ 1,800	Wells
$14,600	

Other conservation systems

$62,000 x .085811 (7%, 25 yrs.) = $5,300
$62,000 x .025 = $1,550

B. Externalities

1. Project take area1/

440 acres range
.23 AUM/ac.
$5.25/AUM
$1.20
-.35 (taxes 15¢, fence 20¢)
$0.85 x 440 acres = $374

111 acres hay

$31.46 net (cost and return)
$31.46 x 111 ac. = $3,492

$3,492 + $374 = $3,866

$3,866
3.395 Type II national income multiplier (Ag.)
$13,200

1/ Estimate from state staff

2. Road relocation

Assumed 2 miles extra travel per day for 30 vehicular trips per day = 60 mi/day x 365 days = 21,900 miles

21,900 mi x .06¢/mi (assumed variable cost) = $1,310

30 vehicular trips per day x 365 days = 10,950 trips
Assume average of 1.5 occupants per trip x 10,950 trips = 16,425 occupant trips

$16,425 \times .50^{1/} \times \frac{20 \text{ minutes extra travel}}{60 \text{ minutes/hr}} \times \$2.50/\text{hr} = \$700$

1/ Assuming 1/2 of the occupants have zero opportunity cost--other half at $2.50/hr

$1,310 + 700 = $2,010 ($2,000)

Regional Development Account

The state of Montana was designated as the region.

I. Regional Income (Beneficial Effects)

A. Increased outputs

1. Flood prevention

RD effects = NED effects

2. Irrigation

RD effects = NED effects

3. Recreation

$35,500	Total recreation benefits
.05	Assumed non-state users
$ 1,775	User effects to R.O.N.

4. Other conservation systems

RD effects = NED effects

B. Externalities

1. Benefits = $216,450 - see NED account, B.1

Regional Costs: (Form B, cost allocation)

$346,065	Irrigation, reservoir
-	Flood prevention
153,370	Irrigation, canals
$499,435 x .05526 = $27,599 ($27,600)	

O&M

$ 3,600	Reservoir
7,170	Ditch rider
1,800	Wells
1,550	Land treatment
$14,120	

Project Administration

$$\frac{\$1,031,471 + \$150,886^{1/}}{\$1,390,000} \times \$50,000^{2/} = \$42,855 \ (\$42,900)$$

1/ Line 8d of Form B, cost allocation
2/ Local project administration cost

$42,900 x .05526 = $2,400

Total regional costs

$27,600	Installation
14,120	O&M
2,400	Project Admin.
$44,120	

$216,450	Benefits
-44,120	Regional Costs
$172,330	
.590	Type II Reg. Income Multiplier (Ag) for indirect and induced effects
$101,674	
($101,700)	

2. Indirect and induced effects from utilization of unemployed resources

a. Hired labor

$47,400	Estimate of increased hired labor
.331	Type II Reg. Income Mult. (services)
$15,700	

b. Recreation service sector

$7,550	See NED beneficial effects C.2
.331	
$2,500	

c. Project OM&R

$7,300	($14,600 x .50)
.331	
$2,400	

d. Land treatment OM&R

$6,700	($535,700 x .025 x .50) NED C.4
.331	
$2,200	

C. Utilization of resources

1. Hired labor

$47,400 Estimate of increased hired labor with project

2. Recreation service sector

$7,550 See NED beneficial effects C.2

3. Project construction and OM&R - See NED C.3

$2,800	Res. construction
7,300	OM&R
860	Canal construction
$10,960	($11,000)

4. Land treatment and OM&R

$ 3,300	Construction	- NED C.4
6,700	OM&R	- NED C.4
$10,000		

II. Regional Income (Adverse Effects)

A. <u>Regional resources contributed</u>

1. Project construction

$609,044 Cost allocation
$609,044 x .05526 = $33,656 ($33,700)

Project administration

$50,000[1/] x .05526 = $2,800

1/ Cost allocation

OM&R

$ 3,600
2,020
7,170
1,800
$14,600

2. Other conservation systems

Construction

$62,000[1/] x .085811 (7%, 25 yrs) = $5,300
$5,300 x .50 (REAP) = $2,650

1/ NED, A.4

OM&R

$62,000 x .025 = $1,550

B. Externalities

1. Project take area

$3,866	NED adverse effects B.1
.590	Type II Reg. Income Mult. (Agr.)
$2,300	

2. Road Relocation

$2,000 NED adverse effects B.2

C. Loss of Welfare Payments

Source data, U.S. Consus and watershed staff
Average welfare payment = $703/yr
6.5% of families on welfare
Project will create 48 permanent jobs
Assume average of 1.25 jobs/family
48 ÷ 1.25 = 38.4 families

38.4	Families
.065	
2.5	Welfare families affected
$703	
$1,755	Direct loss in welfare payments
1.331	Type II Reg. Income Mult. (services)
$2,335	($2,400) Total loss of direct, indirect and induced

Regional Employment (Beneficial Effects)

A. Increase in number of jobs

1. Agriculture

Cost and return data

	$	Hrs.
Crop	$54,490	27,245
Livestock	32,530	16,265
	$87,020	43,150

	Family	Hired
Crop	$ 7,090	47,400
Livestock	32,530	-
	$39,620	47,400

Assuming 2,000 hrs and 1,000 hrs are equivalent man-year employment for crop and livestock respectively, the increased employment becomes:

Crop = 27,245 ÷ 2,000 = 13.6 (14) m.y.
Livestock= 16,265 ÷ 1,000 - 16.2 (16) m.y.
30 man years

2. Recreation sector

$1,700 Non-resident benefits
$1,700 ÷ 1175 (PO-5) = 2

3. Project construction

$1,111,465
.30
$ 333,439 Labor

Assume 40% to skilled and managerial @ $15,000 and 60% to semi and unskilled @ $7.500

$333,439
.40
$133,375.60 ÷ $15,000 = 9 man years

$333,439
.60
$200,063.40 ÷ $7,500 = 27 man years
36 man years

4. Project OM&R

$14,600
.50 Labor
$ 7,300 ÷ 7,500 = 1 man year

5. Land treatment

$535,700
.50 Labor
$267,850
.25 25% managerial @ $15,000
$ 67,000 ÷ $15,000 = 4.5 man years

$267,850 x .75 ÷ 7,500 = 26.7 man years
31 man years

6. Land treatment OM&R

6,700
.50
3,750 ÷ 7,500 = .5 man years

7. Indirect and induced

30
.586
17.6 (18) man years

Regional Employment (Adverse Effects)

A. Decrease in number and types of jobs

1. Project take area

$3,866 ÷ $2 = 1,933 hrs ÷ 2,000 hrs = 1 man year

2. Indirect and induced

1 x .586 = .586 (1) man year

CHAPTER 12

REDEVELOPMENT

This chapter deals with the evaluation of redevelopment benefits that may be expected from the installation and operation of a project. Projects are not designed specifically for the purpose of producing redevelopment benefits but such benefits sometimes may accrue incidentally as a by-product of the project.

I. BACKGROUND

Benefits may be claimed from project installation, operation and maintenance in areas designated under the Area Redevelopment Act of 1961. Such benefits may be derived from added employment as a result of the project and local resources used for the project under specified conditions.

A. Areas of Chronic Unemployment or Underemployment

For an area to be designated under the Act there must have been a chronic and persistent state of significant unemployment or underemployment. In most cases the lack of full employment will be most serious among the unskilled and semiskilled laborers, and rural residents with insufficient farm resources to keep them fully employed on the farm.

B. Need for Outside Assistance

When significant underemployment in an area is persistent, local financial resources become adequate to sustain only a low degree of economic activity. Few resources remain available for economic development after minimum needs are met. Consequently assistance from outside the area becomes necessary if economic activity is to reach normal levels within a reasonable time.

C. Effect of a Project

In areas of chronic underemployment, the installation of a watershed project will bring in outside resources and will provide an opportunity to use goods, services and labor from the local area.

The goods and services produced by the project will tend to stimulate local activity on a more permanent basis. Local labor may be used in producing these goods and services or in supplying the raw materials needed for processing.

II. TYPES OF REDEVELOPMENT BENEFITS AND THEIR EVALUATION

This section describes some of the types of redevelopment benefits

that may be produced by the project, the data needed and the general procedure to be used in their evaluation.

A. Project Installation

When a watershed project is installed, considerable expenditures in the local area are required for the structural measures. There may be some employment of local labor in the preliminary geological and engineering investigations but the greatest opportunity will arise during construction. The contractor usually will have his own skilled heavy equipment operators but is likely to depend heavily upon local sources for his unskilled labor.

In appraising the effect of project installation upon the local employment situation data will be needed on the types and amount of labor used and the prevailing wage rates. Basic information can be obtained from State SCS Administrative Officers, wage boards, and contractors on the usual requirements for labor, and wage rates for the types of labor used. Such information then should be fitted to the local situation.

The labor requirements will depend largely upon the types of improvements to be installed. Requirements for drag-line operation in channel improvement will differ from those in building embankment in floodwater retarding structures. Likewise the ratio of the cost of unskilled labor to total cost will not be the same for ordinary construction as when massive rock is encountered.

The local employment situation also is a factor to be considered. Redevelopment benefits are justifiably claimed only to the extent that the project provides employment to local labor that otherwise would be unemployed or underemployed.

Once the amount of unemployed or underemployed local labor that will be employed by the project and the prevailing wage rates for labor of this type have been determined, it is possible to estimate the total labor income that project installation will provide for the local community. This sum should be converted to its annual equivalent over the project life to determine redevelopment benefits from project installation.

B. Project Operation and Maintenance

Normal project operation and maintenance will provide an opportunity for continuing employment. It can be expected that maintenance will involve a greater use of labor and less of heavy equipment than will installation in relation to the total cost. Furthermore, some project facilities, such as basic facilities for recreation, may provide employment in their operation.

The sources of data for the labor employed in project operation and maintenance are much the same as those for project installation. The

main difference in data is that wage rates used should be those projected over the period being evaluated whereas the prevailing rate applies to installation.

In evaluation of redevelopment benefits from project operation and maintenance, the value of the annual wages paid to otherwise underemployed local labor for these purposes should be determined. It cannot be expected that such underemployment will persist indefinitely. Therefore, the period considered for evaluation should be terminated at not more than 20 years after project installation. It seems likely that during this 20-year period during which redevelopment benefits can be claimed, the employment situation will improve gradually. In this case the wages to be counted as redevelopment benefits would be evaluated as a decreasing annuity beginning at their full value and declining to zero at the end of the twentieth year. The sum so obtained would be converted to an annual equivalent through amortization over the life of the project.

In the case of facilities, such as basic recreational facilities, which have a useful life shorter than that of the project, replacement costs will be included with other operation and maintenance costs. If the useful life of these facilities is 20 years or more, their replacement would not contribute to redevelopment benefits.

C. Employment Stemming from Use of Project Improvements

A third type of redevelopment benefit may arise from the expansion of an existing or the introduction of new industry as a result of services provided by the project. Perhaps the most common development of this type will be in connection with the provision of a municipal or industrial water supply, although it may result from other sources such as freedom from the flood hazard. Definite assurance in writing that the development will take place if the project facilities are provided is a prerequisite to evaluation of redevelopment benefits from this source. Only the benefits from added local employment are eligible for use. Employment of labor imported from elsewhere, or industries which by moving into the area create unemployment problems elsewhere, do not provide redevelopment benefits.

The statement regarding industrial expansion should indicate the number and kind of additional workers that will be employed. This number should be adjusted downward to allow for temporary plant shutdowns, and other normal breaks from full employment. Projected wage rates over the period for which redevelopment benefits are available should be used to determine the increase in annual wages.

Conversion to an average annual equivalent redevelopment benefit should follow the approach used for similar benefits from project operation and maintenance. A period of not more than 20 years during which chronic underemployment can be expected should be used. It can be expected that without the industry the local employment situation would gradually improve. Therefore an annuity decreasing over the redevelopment evaluation

period should be used and converted to an annual equivalent over the project life.

D. Other Possible Redevelopment Benefits

Although redevelopment benefits can be expected with greatest certainty in the case of an existing industry with unused plant capacity, they may arise from other situations. In some cases the installation of a new plant may create employment opportunities during its construction.

Expanded or new industry may increase the demand for local products in addition to providing employment.

Although redevelopment benefits other than those stemming from increased employment ordinarily are not counted for project justification, they should be considered in the detail their significance warrants. If warranted they should be described in order to set forth the significance of the project in the local economy. When they are extremely significant, they may be set forth in monetary terms even though they are not used in project justification.

When redevelopment benefits other than increased employment are evaluated, care should be taken to avoid possible duplication of benefits from other sources. Redevelopment benefits stemming from new industry may duplicate primary or secondary benefits from providing a municipal water supply. Another possibility of duplication might arise if local agricultural products were used as raw materials for processing as a result of plant expansion. If redevelopment benefits were claimed from this source they might duplicate benefits from changed use of agricultural land.

CHAPTER 13

LAND EASEMENTS AND RIGHTS-OF-WAY

This chapter provides some general guidelines and principles for use in the economic evaluation of land, easements and rights-of-way costs.

I. RESPONSIBILITY

Under Service Policy the responsibility for estimating the value of land, easements and rights-of-way rest with the local organization. The responsibility of the Service is limited to testing the reasonableness of the estimate to assure that all economic costs of land, whether purchased or donated, are included in the project cost. Where Recreational or Fish and Wildlife Developments are included as a project purpose and the Federal Government is expected to cost share in the value of land rights the Service has the additional responsibility of assuring a sound use of public funds. Since the cost of land, easements and rights-of-way are paid partially or wholly from local funds, considerable reliance should be placed on the local appraisal. The local sponsors as compared to the Service are in a better position to reflect the local market values and to judge damages caused by severance, particularly those aesthetic values which are more difficult to appraise.

II. LAND RIGHTS

A. Fee Title

Fee title is an absolute ownership of property. Land rights, which may be conveyed to the local sponsoring organization by fee title are often difficult to evaluate on a fair market base because of the change in demand and supply of land for sale in project areas, varying land use, their effect on surrounding land, and many other variables. Legally, it has been determined by Federal and State laws that no private property may be taken for public purpose without the payment of just compensation. The courts have held that just compensation means the fair market value of the property rights taken, plus damages, if any, to the remaining property. The courts have also said that the landowner should be in the "same pecuniary position" before and after the taking.

Land obtained in fee title for public purposes may be secured either by negotiation or condemnation proceedings.

1. Method of Acquisition.

a. Negotiation

Land may be secured through private negotiation between the sponsors and the land owner. Such proceedings are normally on the base of a willing buyer and unwilling seller. However, a price may be set by negotiation that is satisfactory to the seller, or at least he may

assume that he will be better off than what he would be if he went through court action.

b. Condemnation Proceedings

The right of eminent domain is the power belonging to the Government to take private property for public use without the consent of the owner. Many local organizations, when unable to obtain land rights by negotiation have the authority to institutue condemnation proceedings. Procedure for condemnation of land depends upon applicable statutues, with methods of determining values varying somewhat, from one legal jurisdiction to another. Generally, however, the determination of just compensation is finally made by a jury, though sometimes by agreement of the parties involved, or by the court itself. Through the years, court decisions have established the meaning of just compensation as being the fair market value.

2. Fair Market Value

The following are some general principles of establishment of fair market values:

a. Fair market value is defined as the amount that would be paid by a willing buyer, not compelled to buy, and accepted by a willing seller, not compelled to sell.

b. Property values tend to change with time. Values should be based on the supply and demand of land at the time the land will actually be required for project purposes.

c. Property should be evaluated as a unit without regard to ownership or encumbrances. The effects of the acquisition of part of a tract on the remainder should be considered in the evaluation.

d. Timber, other crops, and natural resources should not be evaluated separately except when ownership is severed from the land.

e. Special values to the property owner, such as sentimental value, are not considered in value determinations. Such values are special and peculiar to the owner and do not effect the market value.

f. Any enhanced value of the land resulting from project installations is not considered in value determination when an entire ownership is acquired.

g. When only a part of an ownership is acquired, value determination should include consideration of benefits accruing to the remaining land as a result of the project only to the extent that they offset severance damages. Courts usually have ruled that the created benefits are only offsetting against severance damages caused by depreciation of remaining land. Benefits created in excess of severance damages are excluded from

consideration. Severance damages may be only temporary in nature and be valid only for a reasonable period which is necessary for adjustment to take place.

B. Easements

Easements are distinguished from fee title as they do not transfer ownership. An easement is any of several rights which one may have over another's land. The following principles apply to easements:

1. Easements are fractional property rights.

2. Easements involve the transfer of something less than all of the rights inherent in absolute fee ownership.

3. The value of an easement is some amount less than the market value of the property before the easement was granted because some residual value remains even though it may be insignificant.

4. Easements rarely can be evaluated by comparison. The test of what constitutes the market value of easements does not lie in what buyers have paid for other easements, but rather in what the general buying public does in the real estate market in discounting the prices paid for real estate market in discounting the prices paid for real estate where easements of similar type have been granted.

5. Some types of easements may actually increase the value of the remaining portion of the tract on which the easement is granted.

6. In view of the limited conveyance of rights, it is possible for more than one easement to be granted on the same tract of land, provided the rights previously granted are not duplicated or interfered with.

7. An easement may cover only a fractional part of a tract of property.

8. Severance damages may be caused by the granting of an easement. A reliable test for severance damages is the "before" and "after" or "with" and "without" comparison of land value.

9. Severance damage caused by granting an easement is considered not to exist in perpetuity, but only for the life on any affected improvements, or a reasonable period of time for the owner to adjust to alternate uses.

10. When easements are acquired by condemnation, courts usually have ruled that benefits created by an easement are offsetting only against severance damages created at the same time. Any benefits created above severance damages are excluded from consideration.

III. METHODS OF ESTIMATING VALUES

Three basic approaches, or correlations thereof, may be used for evaluation of land and allowances for land improvement.

A. Market Data Approach

The market data approach is most often applied to determine fair market value of farm land. This method involves comparisons of market values of similar land at current prices. Included in use of this method are such considerations as speculative interest, land zoning regulations, special easements or tax evaluations, circumstances relating to sales, the shape, topography and size of the tract, and its accessibility in relation to farm commodity markets, roads, schools, churches, and related cultural facilites.

Qualified land appraisers, real estate agents, local loan agency officials, etc., are prime sources of assistance in estimating fair market values.

B. Capitalized Value of Net Income

Another approach is the income capitalization method. It is based on productive capacity of the land and involves an estimate of net income accruing to the land and choice of a capitalization rate. Where cash rental or leasing is common, this determination is relatively simple. The capitalized rate should be at the average interest rate for real estate mortgage loans and for land sales contracts in a fairly wide area. Caution should be exercised in placing too much emphasis on the capitalized value of land as many uncertainties such as the marginal value productivity of land in respect to future prices and costs, interest rates, etc., are involved in the computation. Normally, it is inferior to the market data approach based on local supply and demand of land.

C. Cost Approach

The cost approach is a partial analysis whereby price is determined through the computed cost of the separate components of land. When farm improvements are of such a nature that no sales or income data are available, it may be necessary for them to be evaluated separately from the land by using the "replacement cost-less depreciation" approach.

Cost estimates of non-farm improvements such as buildings, public utilities, oil or gas pipelines, highways, bridges, and railroads generally can be prepared on the basis of relocation in kind, modification or salvage costs.

Where land values are determined by potential use for urban-industrial, commercial, or residential use, additional factors must be con-

sidered. In the absence of any known sales of similar land for such purposes, any values set above those reflecting present land use would have to be based on the early likelihood of changed use, the asking price of several owners, relative location and desirability of property for such use, and the probable time when demand will result in sale at a given price discounted to present worth.

IV. LAND RIGHTS COSTS TO BE INCLUDED IN THE ECONOMIC EVALUATION

Land, easement, or rights-of-way costs should reflect costs (values) of the land rights acquired without any adjustment for offsetting benefits. Included in this cost would be the full values of the land rights based on either market values or income losses, time and travel expense associated with the acquisition of land rights, legal fees, recording fees, and other incidental expenses.

For Federal land, these costs (values) will be limited to the costs for a special use permit (issuing, recording, etc.) including the cost, if any, of complying with its provisions (e. g. relocations, modifications etc.).

Land rights to be evaluated for reservoirs should be limited to the area used by the dam, emergency spillway, storage area, borrow, and/or areas of siltation above the pool elevation under special circumstances. Where Recreational or Fish and Wildlife Development is included as one of the purposes, additional land rights will be required to assure public access and enjoyment of the development and of any associated minimum basic facilities.

Disposition of spoil, in case of channel improvement, may require easements and/or consideration of reduced production in the affected areas. Flowage easements may be needed if release rates from structures or channel improvement cause prolonged submergence or temporary high peaks which induce damage.

1. Other Economic Costs

If the income losses from the changed use of the sites are greater than the annual equivalent of the estimated acquisition cost, then the difference should be charged to the project as "other economic costs." On the other hand, if the sponsor's estimate is unreasonably high considering all costs that may be required for acquisition, the effects of the estimated cost on the benefit-cost ratio and cost allocation and cost sharing should be thoroughly explained to the sponsors. Circumstances may require an outside appraisal.

Chapter 14

SHORTCUTS IN EVALUATION PROCEDURE

The economist is faced at all times with the problem of balancing scanty data against the cost and time required to obtain and analyze more complete information. It may be necessary to adopt certain assumptions and to develop shortcut procedures in order to obtain reasonably accurate answers with minimum planning costs. When so doing, he must remember that assumptions are not necessarily facts.

This chapter describes some considerations involved in shortcuts to economic evaluations. It outlines circumstances where shortcuts are feasible and methods of checking to determine if shortcut results are valid.

I. PURPOSE OF SHORTCUT PROCEDURES

The obvious purpose of shortcut procedures is to save time and money. Stemming from this, of course, is the fact that if time or money is saved, more work can be accomplished by the expenditure of a given quantity of resources.

A less obvious outcome of shortcut procedures is that they may improve the quality of the overall evaluation. If used properly, they release time for more careful study of critical obscure points in the evaluation.

II. CONDITIONS CONDUCTIVE TO EFFECTIVE USE OF SHORTCUTS

A. Broad Knowledge of Problem

As general knowledge applicable to the problem at hand increases, the detailed information required for evaluation is reduced. Such general knowledge may come from a variety of sources.

Information usually is available from similar situations and is helpful in defining the general limits of answers to a particular problem.

In most cases there will be a variety of approaches to use in evaluation. A thorough grasp of fundamental economic principles will help the worker select the most efficient approach to solution of a given problem.

Shortcuts in economic investigations can be used most effectively if the economist has a general understanding of the data from other specialized fields and the limitations thereof.

Another prerequisite to the sound use of shortcuts is an intimate knowledge of the pertinent physical and economic features of the area in-

volved. Economic analysis is something more than the mere mathematical and statistical manipulation of figures. Unless tempered with over-all knowledge and judgment, blind reliance on mathematical calculations, no matter how complex, may lead to totally unrealistic answers.

B. Known General Outcome

The detail in economic investigations may be reduced when the general nature of the outcome is known in advance. When economic justification is certain, there is no need to prolong economic studies to determine if the ratio of benefits to costs is 3.12:1 instead of 3.0 to 1. Likewise, if failure of economic justification is assured, detailed study will be wasted.

C. Size and Complexity of the Project

As the size and complexity of projects increase, the amount of time required for economic appraisal also increases, although not necessarily in direct proportion.

When a project includes multiple-purposes, the detail required will be increased. Sufficient time is required to make certain that each project facility has the capability of meeting the needs specified. Evidence that each of the purposes included is justified must be obtained. In many cases, especially where flood prevention and drainage are involved, additional investigations are needed for cost allocation. Finally, multiple-purpose projects often involve inter-relationships among the effects of the various purposes. Careful economic analysis often will be needed to determine whether these effects tend to complement or nullify each other.

The sampling intensity may be reduced when the area encompassed by a project is relatively homogeneous. If, however, there are numerous variations in conditions, the overall sampling will need to be increased in order to be sure that significant variations have been sampled adequately. In addition, thorough analysis will be needed to be sure that the effects of one variation upon another, if any, have been uncovered.

The amount of time spent in economic investigations should be related to the cost of the project. Obviously more time can be spent profitably in determining if a $5,000,000 expenditure is justified than if only $100,000 is involved.

Another determinant of the need for investigative thoroughness is the relationship of the project with other projects. A common example of such a situation is where the project area constitutes a component part of a larger watershed area and works of improvement within the project area can be expected to affect downstream areas. Investigations need to be in sufficient detail in such cases to determine the general magnitude of downstream effects and whether they are benefits or induced costs.

III. POSSIBLE SHORTCUTS

A. Empirical Relationships

As experience is gained in watershed planning a body of data is acquired. Analysis of this information may disclose relationships that can be stated as empirical formulas or equations. In many areas a study of flood damage to crops has provided information that relates damage to depth, duration and season of flooding with applicability to wide areas. When relationships such as these are developed, much saving can be obtained in expensive field investigation to determine crop damage rates in a given watershed. Then only enough crop damage investigation needs to be made in each case to determine if adjustments in the overall rates are needed in that particular watershed.

Another relationship that may be set out in empirical form is the effect of recurring flooding on crop damage. An equation of this type developed for the Historical Series method is illustrated in Chapter 3, II, B. Such a device enables one to accomplish in a few minutes that which would require hours or days if a flood-by-flood correction were used.

Information is becoming available on the use of sediment pools of floodwater retarding structures for incidental recreation. This information, when carefully analyzed, forms a basis for estimating the use that will be made of other sediment pools under similar situations.

Other illustrations could be given. Each economist should be alert to the possibility of developing such relationships. Time spent in exploration of this type may be most productive. Once a tentative relationship is determined, however, it should be tested under various situations to determine its accuracy and how widely it may be used.

B. Analysis of Needs

A great deal of time can be saved if the economist carefully analyzes his needs for data before he starts collecting information. There is no virtue in collecting useless information; efforts should be centered on obtaining data relevant to the problem at hand. Field schedules should be limited to those necessary to obtain reliable information, for interviewing is an expensive procedure. Reliance should be placed upon simple statistical tests, such as determination of standard error of estimate, to determine if the confidence limits of the data have been narrowed sufficiently. Enough background information should be obtained to guide the economist's judgment in interpreting and analyzing the formal data he has obtained.

Careful selectivity in sources of data is necessary. Applicable secondary data may be readily available. On many technical problems, a consensus of expert judgment may be sufficient. Experts may have developed "rules of thumb" that will be adequate for a given problem.

Much time may be saved if consideration is given to the degree of accuracy required. Economic analysis depends to a large extent upon physical data developed from other disciplines. There is no merit in refining economic data to a point that it is inconsistent with the refinement of the physical data with which it is associated. In fact, refinement beyond that which is clearly necessary is not only wasteful but may mislead others to assume that its reliability is greater than is actually the case.

C. Opportunity Cost Principle

The net income foregone by using any input for a specific purpose rather than in the best alternative use is called an opportunity cost. For example, the funds invested in farm machinery and other farm investments could earn interest if placed in "E" bonds, or deposited in a bank or savings and loan association. Unpaid family labor usually could earn wages if employed elsewhere. These are opportunity costs or earnings foregone.

In some cases the principle of opportunity costs may be the only feasible means of determining values. At least, this will set limits to the possible values.

D. Analagous Situations

Consideration of analagous situations may be helpful, especially if the data does not lend itself to quantification through empirical means. It is important here to use only situations that are truly analagous.

IV. CHECKS AND BALANCES

Whether shortcuts or more detailed studies are used, there should be some system of checking on the answers obtained. Some methods are outlined briefly in this section.

A. Statistical Tests

Arithmetic means may be misleading whether they are simple or weighted averages. They may be biased easily by improper sample selection, or by extreme values. It is helpful to compare them with median and modal values. In many cases a frequency analysis may be useful.

The economist often will find it helpful to submit his data to such tests as standard deviation and standard error of estimate. These will give an indication of the central tendency and reliability.

Graphical methods of analysis should not be neglected. When the data is plotted, relationships often stand out vividly. References that are most helpful in graphic analysis are Agricultural Handbooks No. 84, June 1955; and No. 128, July 1957.

Graphical methods are very helpful in estimating trends whether mathematically fitted or free hand curves are used. When an appropriate scale is used, interpolations within the limits of known values may be made with confidence. However, extreme caution should be used when extrapolating much beyond known data.

Statistical techniques such as regression and correlation analysis and occasionally analysis of variance may be helpful in interpreting relationships.

B. Multiple Checks

An excellent test of reliability is to check results obtained by one approach against those obtained from another. This is especially true in checking shortcuts. One shortcut method may be checked against another or against the results from detailed analysis. Comparison through checking results from one detailed appraisal against another may be desirable at times.

Unless used with discretion this procedure would counterbalance the saving in time attendant upon the use of shortcuts. It is almost essential, though, in the development of shortcut procedures in determining their reliability and the limits of their applicability.

C. Reasonableness

In economic analysis the fundamental test is to determine if the results are reasonable. Experienced judgment will allow this test to be made in many cases without much mathematical investigation. It is possible, however, for even the inexperienced economist to make simple tests to determine the reasonableness of his answers. For example, does the average annual flood damage to crops exceed the net return that the farmer could expect if they were not flooded? If the damage is such that the farmer will lose money consistently, he is not likely to continue his present use of the flood plain over the long run unless such use complements the use of his other resources. When confronted with a situation of this type, the economist will re-examine his damage estimate. If these, including the estimated flood frequency and severity, are in order, he will check his estimate of land use. If no change is indicated, he will analyze background information to determine if there is a reasonable explanation of such a situation.

A similar approach is indicated in most situations where the answers appear unreasonable.

CHAPTER 15

ECONOMIC PROJECTIONS

> "We must involve the American people in setting goals and priorities by providing accurate, credible data on the long-range choices open to them, making possible much better informed public discussion about using the resources we will have in meeting the needs of the future."
>
> Economic Report of The President
> Transmitted to the Congress,
> February 1970.

I. INTRODUCTION

The purpose of this chapter is to provide guidelines and material on the use of economic data and projections in assessing project benefits and costs over the project life.

Water and related land resource development projects are generally designed with the physical capacity to provide project outputs for a period ranging up to and including 100 years. Looking back only a decade or two, the changes that have occurred in the physical growth and development of our economic environment have been dynamic. In all likelihood this trend will continue. Therefore, it is imperative that watershed and related land resource projects be formulated to meet not only the present, but anticipated future needs for water-related goods and services. Evaluations of economic feasibility should account for these anticipated needs.

Estimates of changes in future economic growth and related activities are set forth in various published projections. Projections are based upon examination of historical trends, analysis of current relationships and an evaluation of foreseeable developments. Major factors considered are resources, population, employment, and income.

In March 1964, the Office of Business Economics, U.S. Department of Commerce, and the Economic Research Service (ERS), U.S. Department of Agriculture, undertook a nationwide economic base study for the Water Resources Council (WRC). This study was designed for use in water and related land resource development planning. Preliminary data have been published by the WRC. Copies have been provided to the SCS state offices. A final report is expected to be available in 1971.

The objective of the OBERS program is the measurement of economic activity of specified areas of the Nation currently and at intervals over the next 55 years. This information forms a basis for estimating future economic needs for the development of water and related land resources.

The economic base is presented in two major parts: (1) an historical and current picture of the economy of each area; and (2) a projection of economic activities for the years 1980, 2000, and 2020. Estimates of national requirements for time frames have been disaggregated by ERS to regions and in some areas to basins and subbasins. Each estimate reflects the projected requirement for food and fiber for that area based upon its historical rate of performance. Further studies to reflect comparative advantage for agricultural production among regions are currently underway by ERS.

Project evaluation requires interpretation of projections and the development of localized factors for use in assessing project benefits for the full range of developments likely to take place throughout the project life.

A. Baseline Projections

Projection of demands for water-related goods and services and their translation into needs for water and related land resource developments are a central element of the planning process. Projections, however, represent our best estimate of future development, but should not be considered as absolute or infallible. For water resource planning purposes, projections should be used only as one of many planning tools.

1. Their Applicability to Water Resource Planning: The baseline projections were designed primarily to be used as a planning tool in the evaluation and formulation of water and related land resource programs. Basically, these projections provide a systematic approach at the national level for identifying the areas of strength and weakness in the national economy. Probably the most important function of the projections is that they provide a vehicle for evaluating national priorities to establish water resource policies of the Federal Government.

2. Purpose: The major purposes of the baseline projections are: (1) to enable planners to appraise present and future supply and demand relationships for goods and services as they exist under current levels of water resource development; (2) to establish a basis for examining the capabilities of the existing resource base in satisfying future demand for goods and services; and (3) to provide a basis for evaluating resource development that is related to present or projected levels of regional economic activity which is consistent with projected national growth.

3. Assumptions: A number of conditions were considered in the formulation of the baseline projections. Among the most important were: (1) the Government will enact programs and policies to ensure full employment; (2) the projections would be free of the distorting effects of wars; (3) technological advances in producing goods and services would continue at near the present rate of development; (4) the overall demand for goods and

services will continue to expand as the result of the anticipated growth in population, increases in personal income and increased consumption by domestic and foreign users; and (5) water will play the same role in stimulating or depressing economic growth in the area in the future as it has in the past.

4. Formulation: The national forecasts were measured in terms of aggregates such as population, labor force, employment, unemployment, and personal income. These estimates were later disaggregated among the various OBE planning areas on the basis of historical shares and assumed rates of regional economic growth.

Additional projections of agricultural production and associated land use patterns in the major producing areas and water resource regions are based primarily on the comparative advantage principle. The projected availability of agricultural land over time are reflected in comparative advantage and hence influence the projected pattern of agricultural production among regions and subregions. The revised OBERS projections are based on the assumption of no shifts in the major uses of land; i.e., pasture or forest to cropland--and no major Federal water resource projects or program over those now authorized and funded. An allowance has been made for continuing loss of agricultural land to urban and related buildup, continued private development of irrigation, and the depletion of ground water supplies for irrigation.

5. Limitations: The Uncertainty of Predicting Future Events: Since planners are limited in ability to predict future events, projections must not be interpreted as explicit statements on what will happen in the future. Projections show potential production relationships, possible technological changes and economic effects. These relationships and effects must be considered and analyzed by the planners in the evaluation of the watershed and related resource plans.

As plans are developed, they will rest on predicated conditions which are, in fact, uncertain. Alternative assumed conditions should be examined for effects on the relative feasibility of plans.

II. GENERAL

The basis of project evaluation is the determination of the effect(s) the project will have in modifying conditions that would exist over the evaluation period without the project both from a national and regional viewpoint. Therefore, proper evaluation requires consideration of projections of the physical and related economic conditions that would be expected over the evaluation period for both with and without the project. This necessarily requires a determination of the role water and related land resource developments play in order to meet economic and social needs now and as projected in the future.

Water and related land resource developments can provide an impetus to economic growth of stagnant, undeveloped, or underdeveloped areas. Many areas have not developed consistent with their inherent resources. The reasons for this stagnation or the lack of attaining potential growth may be varied. These inhibiting factors often are referred to as bottlenecks. Inhibiting factors to economic growth and development are varied and collective in nature. They include a combination of such factors as availability of capital, governmental policies, social characteristics of the area, natural resource limitations, etc. The threat of flood damage, inadequate water supply, poor water quality, or the lack of recreational opportunities are other bottlenecks to economic growth. These may exist singularly, in combination with each other, or in combination with other restricting factors. Planned removal of bottlenecks often triggers economic growth and gives rise to unemployed resource benefits and/or external production benefits. These probable effects which may occur as a result of watershed projects must be estimated based upon the collection and analysis of various data.

III. ROLE OF PROJECTIONS IN THE PLANNING PROCESS

A. River Basin Studies

River basin studies include framework studies and assessments of overall water and related land resource problems and development potentials, or regional or river basin plans.1/ Required in every river basin study are the projections of economic activities and development and translations of these projections into needs for water and related land resource uses by specific time frames. Through the comprehensiveness of river basin studies and their coordination with other federal and state agency programs, needs, as identified in river basin studies, should encompass all foreseeable demands for water-related goods and services. As such, river basin reports are a good source of information for subsequent planning for authorizing documents and implementation studies.

Depending upon the type of survey, potential solutions to meet identified needs are formulated either as a general or detailed appraisal of project opportunities. Potential water and related land resource developments are formulated as meeting either short- or long-range needs.

Watershed investigations reports are prepared for each potential upstream watershed recommended for initiation in the next 10-15 years. These reports identify the physical and economic opportunities of potential water and related land resource developments. As such, watershed investigation reports provide essential information to local people for their use in developing realistic and meaningful objectives. They also assist in deciding

1/ As designated in A Policy Statement, Water and Related Resources Planning, Water Resources Council, Washington, D.C., July 22, 1970, the framework and assessments are similar in intensity to the previous Type 1 studies. The regional or river basin plans are similar in intensity to the previous Type 2 and 4 studies.

on the scope and scale of project development local sponsors desire in subsequent planning of P. L. 566 watershed projects or resource conservation and development projects within current policy constraints.

B. P. L. 566 Watershed Projects

In contrast to river basin studies, the responsibility for decisions with respect to scope and scale of water and related land resource developments in P. L. 566 watershed projects is a joint effort between the local sponsoring organizations and the involved state and federal agencies. It is essential, therefore, that the project sponsors and other local planning groups recognize this responsibility and determine their objections based upon as complete a source of all relevant data and Projections as can be assembled. Much of this data can be obtained locally through local improvement committees, planning authorities, county commissioners, town councils, tax assessors, etc.

C. Project Evaluation

1. Land use projections

Based upon all available sources of data, projected economic needs, and upon the judgment of the planning staff and local people, estimates must be made of future land use by time frames. One of the first analyses to be made is the future requirement of land for agricultural and non-agricultural uses. The estimates of future requirements for nonagricultural use must be broken down by major categories, such as residential, commercial, and industrial, transportation and transmission, open spaces, etc. Land remaining in agricultural production should reflect possible changes in the cropping pattern by time frames. Consideration must be given to the redistribution of agricultural uses within farm units such as between upland and flood plain lands and/or between project service areas and nonservice areas.

2. Agriculture Yield Projections

The evaluation of benefits from agricultural production should reflect not only the anticipated agricultural use over time but also expected future productivity. Conditions existing at the time of planning are only benchmarks from which projections are developed. It is recognized that a lapse of time between planning and completion of the project exists, and conditions expected about 10 years after planning should be considered as the beginning of the evaluation period.

Estimates of future agricultural productivity should be based upon all available pertinent secondary data about the effect improved technology will have on crop yields. OBERS projections are a source of such data. These estimates must be tempered for local conditions and activities by those knowledgeable about such. Estimates of flood damages

and benefits from more intensive land use and changed land use should reflect increases in expected future yield levels. At the same time it should be kept in mind that as yield levels increase, increases in production costs will also occur.

3. Damageable Values to Properties

In estimating flood damage to agriculture and nonagriculture properties, it will be necessary to take into consideration changes in the amount and value of such properties over time. As more consumer items become available and as society becomes more affluent, it can be expected that consumers will acquire a greater accumulation of durable goods. One indication of the increase in the amount and value of durable goods would be to relate it to projected increases in per capita personal income. Since floodwater damage to real property is reflected mostly in labor costs, these damages (remedial costs) would increase also in accordance with per capita personal income. However, in making these estimates of future damageable values it may be necessary to take into consideration changes in income elasticity between durable and nondurable goods and changes in propensity to save with higher incomes.

4. Future Demand for Water Storage

Estimates of quantity of water storage for such purposes as municipal and industrial water supply, recreation, irrigation, water quality for aesthetic values, etc., should be based upon present and projected future requirements and price levels. Underlying such estimates should be projections of increased population, increased average per capita incomes, increased per capita water consumption, re-cycling and re-use of water, improved agricultural and industrial efficiency, a shorter work week with more leisure time, and increased mobility of people. The potential of project installation, for the intended purposes, in stimulating local economic growth should also be considered.

IV. USE OF PROJECTED DATA

A. Crop and Pasture Damage

Projected land use, crop distribution, and yield levels by time frames must be considered in deriving average annual crop and pasture damage. Guidelines for appraising this damage are contained in Chapter 3. In addition to determining the average annual equivalent flood damage, it is necessary in river basin studies to estimate flood damage for each time frame (present, 1980, 2000, and 2020). This type of information is necessary in river basin studies to set priorities of potential water and related land resource developments into an early-action or long-range program. Similar information will be necessary in P. L. 566 watershed work plans to describe the magnitude of flood damages over the evaluation period and in assessing the full beneficial effects of the project.

Required in this analysis is the selection of a base year for determining average annual damages. Since near to present values are most reliable, it is suggested that the first year (end of the installation period) of the evaluation period be used as the base year. This would approximate ten years following planning. Estimates of damages for all other points of time through the evaluation period would be referenced to the base year.

In the following example, references are based upon index factors of gross production.

Example

Watershed X (hypothetical data)

Land Use*

Year	Total (acres)	Agriculture (acres)	Nonagriculture (acres)
present	1,000	900	100
1990	1,000	850	150
2000	1,000	750	250
2020	1,000	700	300

Agricultural Use*

Year	Total	Corn (%)	Wheat (%)	Alfalfa (%)	Pasture (%)
present	900	50	25	5	20
1990	850	55	25	5	15
2000	750	57	23	5	15
2020	700	60	20	5	15

Yield Levels*

Year	Corn (bu)	Wheat (bu)	Alfalfa (T)	Pasture (AUM)
present	60	30	2.5	3.0
1990	80	35	2.7	3.5
2000	100	40	3.0	4.0
2020	120	50	3.2	4.5

---

* This type of information for projected time periods would be based on projections of population, county metropolitan and regional development plans, highway development plans, river basin studies, ERS projections, Extension Service data, etc. This information would need to be correlated with information obtained from flood plain schedules.

Gross Production

Present condition (1980)

Crop	Acres	Production	Price 1/	Gross Value 2/
Corn	450	27,000 bu.	$ 1.05	$28,400
Wheat	225	6,750 bu.	1.30	8,800
Alfalfa	45	112.5 T.	22.00	2,500
Pasture	180	540 AUM	3.50	1,900
	900			$41,600

1990

Crop	Acres	Production	Price 1/	Gross Value 2/
Corn	468	37,440 bu.	$ 1.05	$39,300
Wheat	212	7,420 bu.	1.30	9,600
Alfalfa	42	113.4 T.	22.00	2,500
Pasture	128	448 AUM	3.50	1,600
	850			$53,000

2000

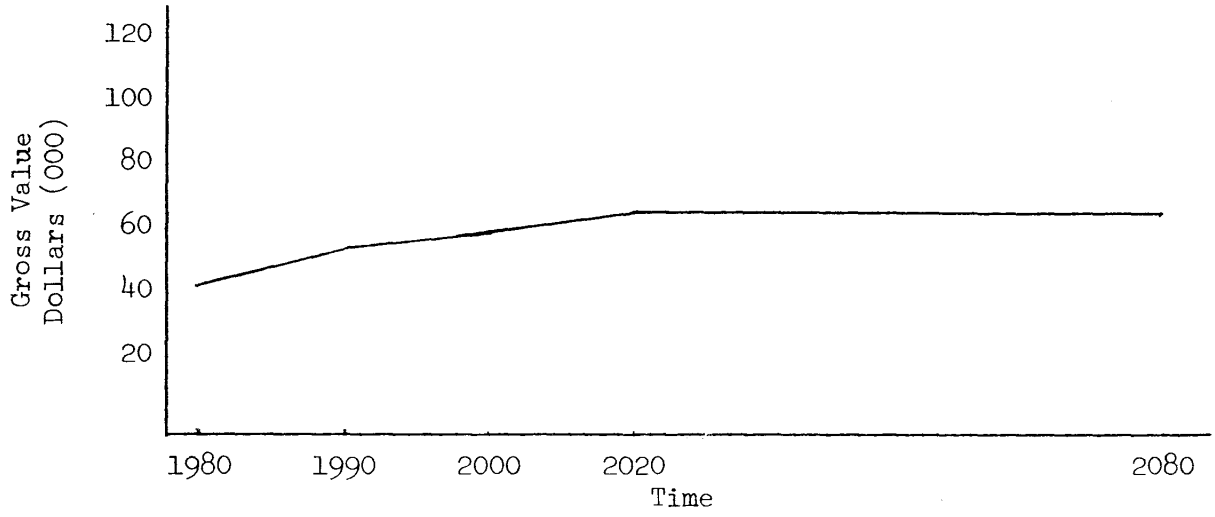
Crop	Acres	Production	Price 1/	Gross Value 2/
Corn	428	42,800 bu.	$ 1.05	$44,900
Wheat	172	6,880 bu.	1.30	8,900
Alfalfa	37	111 T.	22.00	2,400
Pasture	113	452 AUM	3.50	1,600
	750			$57,800

2020

Crop	Acres	Production	Price 1/	Gross Value 2/
Corn	420	50,400 bu.	$ 1.05	$52,900
Wheat	140	7,000 bu.	1.30	9,100
Alfalfa	35	112 T.	22.00	2,500
Pasture	105	472 AUM	3.50	1,700
	700			$66,200

1/ Adjusted current normalized prices.
2/ Rounded off to nearest hundred dollars.

A plotting of this information shows the relative values for each of the time frames as follows:



Because projections are not presently available beyond the year 2020 and of the uncertainty of extending them further, this example assumes a constant value from 2020 to 2080.

As more reliable information becomes available and as projections are extended through passage of time, the appraisal will need to be reevaluated for the various time frames.

Using an index of 1.0 for present values (1980), the respective index values for each of the other time frames are 1.3 for 1990, 1.4 for 2000, and 1.6 for 2020 through 2080.

For purposes of this illustration, it is assumed that average annual crop and pasture damage under present conditions (at the end of the project installation period--1980) is $100,000. Thus, based upon the derived indices, estimates of damage for each point of reference become $130,000 for 1990, $140,000 for 2000, and $160,000 for 2020 through 2080.

These values can then be discounted at the appropriate interest rate(s), using a straight line relationship between time frames to arrive at an average annual equivalent damage in adjusted current normalized prices.

In river basin studies a family of curves can be drawn denoting average annual equivalent damage by various interest rates. These curves will assist in project formulation(s) and selection of early-action proposals.

Guidelines for appropriate discounting are contained in Appendix A, Economics Guide, and various E&WP Unit Technical Notes.

A short-cut procedure to the above approach which may be used in instances where it may not be necessary to relate damages by time frame, such as the investigation and analysis of certain P.L. 566 watershed work plans, would be to use projected data for the 20th year of the evaluation period to represent the average land use, cropping pattern, and yields throughout the evaluation period. Variations in the methodology used will depend upon determination of the reliability of basic data available, stability of local economic conditions, to mention a few of the factors requiring analysis.

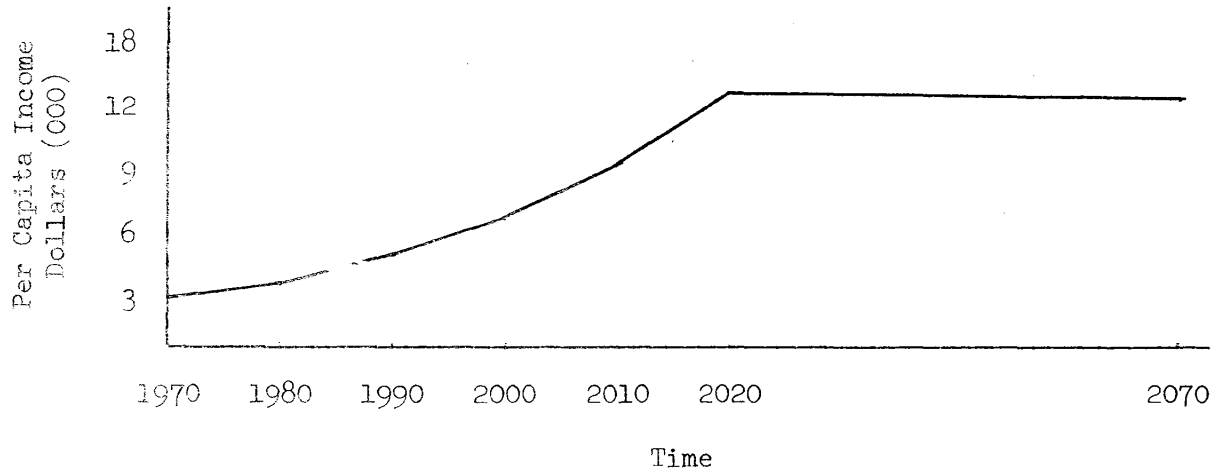
B. Nonagricultural

Damage estimates to residential, retail-commercial, industrial, farm property, etc., are usually obtained through interviewing residents in the flood plain and local officials. Data collected are either estimates of damage occurring at the time of the flood or adjusted to reflect damageable values at the time of the interview In either event, damage estimates reflect current or past inventories of amount and value of labor and properties. These estimates should be adjusted to reflect (1) normalized current price relationships, and (2) physical and economic conditions expected to prevail over the evaluation period <u>without</u> the project.

One method to account for future increases in damageable values, which is easy to apply and utilizes readily available data, is to assume that damage to durable goods will increase as per capita income increases. Using historical and projected per capita income values from Office of Business Economics (OBE), a ratio of future income to present income can be obtained. This ratio can be applied to the base year estimate of average annual damage to obtain an adjusted estimate reflecting average annual damage to present and projected damageable values.

An example of determining this adjustment factor using projected per capita income figures for the United States as prepared by OBE is depicted below. The adjustment factor is based on a 100-year evaluation period using 1970 as the base year. An interest rate of 4-7/8 percent was used to discount future values to present worth. A straight-line build-up between the various time frames is assumed. In the example, projections of per capita personal income beyond 2020 were held constant at the 2020 level.

Year	Per Capita Income
1970	$ 3,046
1980	4,112
1990	5,346
2000	7,161
2010	9,467
2020	12,411



The adjustment factor after proper discounting of per capita incomes approximates 1.9 for the United States data. Caution should be observed in application of the adjustment factor to all types of flood damage estimates. It is doubtful the factor has realistic applicability to damage estimates other than for industrial and commercial properties and urban and rural residential developments.

A refinement of the above procedure would recognize changes in income elasticity between durable and nondurable goods and a change in property owners' propensity to save with higher income.

The basis for establishing an adjustment factor for a particular region or water resource planning area will depend upon a proper analysis of the economic indicators available and pertinent. Sufficient economic analyses should be made, on a case-by-case basis, in order to provide assurance that the most appropriate economic indicator has been selected for computing the adjustment factor.

V. SOURCES OF PROJECTIONS

The OBERS report previously mentioned includes historical and projected data on population, employment, personal income, and aggregate demand level requirements for food and fiber, and is a prime source of data.

Another source of broad economic projections is the first national assessment of the Water Resources Council, entitled "The Nation's Water Resources."

Sources such as U.S. Census; state, county, and regional development plans; overall economic development plans for counties; utility companies' plans and projections for service; the Forest Survey; and county and local

tax assessment records should be examined as a part of the process for determining economic indicators of an area's growth potential.

The use of projections in project evaluation relates to many of the principles set forth in other chapters of this Guide. Projections in the evaluation of benefits must be used in order to properly assess the needs for goods and services over the evaluation period.

Property of KRC

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
1218 S. W. Washington Street - Portland, Oregon 97205

SUBJECT: Economics Guide for Watershed Protection & Flood Prevention, Chpt. 10 - Proposed Revisions

DATE: January 12, 1970

TO: Erwin C. Ford, Economist, Watershed Planning Division, SCS, Washington, D. C.

At the meeting of the Western States Economists in May, 1969 we discussed some of the weaknesses of Chapter 10 concerning the Separable Cost-Remaining benefits method and the Alternative Justifiable expenditure method of cost allocation.

The attached sheets are suggested revisions and additions to this chapter that I feel would be helpful to anyone contemplating the use of one of these methods.

Copies of these revisions are being sent to the Portland, Oregon E.& W.P. Unit Economist and Watershed Planning Specialist.

Thank you for your attention and help in this matter.

Keith Cromwell
Economist

cc: E.W.P. Unit Watershed Planning Specialist
E.W.P. Unit Economist

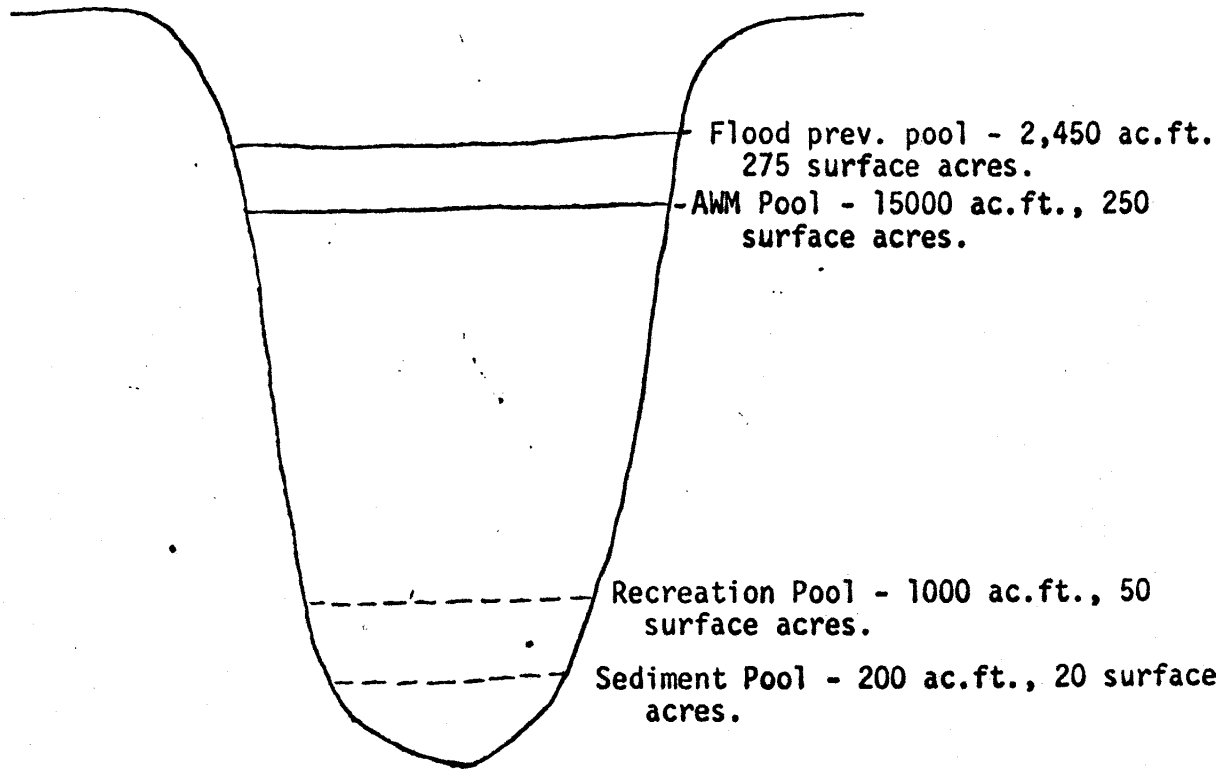
USDA-SCS KRCromwell:lf 1/12/70

SUGGESTED REVISIONS - CHAPTER 10 - ECON GUIDE

P. 2 - B. - Reservoir-type Structures

Acceptable cost allocation methods for reservoir-type structures are (1) use of Facilities Method, (2) Separable Cost-Remaining Benefits Method, and (3) Alternative Justifiable Expenditure Method. Of these, the use of Facilities Method is the easiest to calculate and is readily understandable by non-technical people. Under current Service policy, it is the preferred cost allocation method. Of the other two, the Separable Cost-Remaining Benefits method is preferred unless the cost of making the studies necessary for estimating separable costs is excessive.

Following first paragraph: A sketch or diagram like the one shown below is helpful in setting up the data needed for a cost allocation. The diagram also helps when the allocation is reviewed with the E. &. W. P. Unit or explained to the sponsors.



Total Capacity - 18,650 ac. ft.
Area needed for dam & reservoir - 300 acres.

2. Separable Costs - Remaining Benefits Method

The separable costs-remaining benefits method provides for (1) assigning to each purpose its separable cost, i.e., the added cost of including the purpose in the project; and (2) assigning to each purpose a share of the remaining or residual joint cost in proportion to the remaining benefits, i.e., the benefits (as limited by alternative cost less the separable cost). Thus the method provides for an equitable sharing of the savings from multiple-purpose development among the various purposes included.

It should be noted that the separable costs-remaining benefits method will allocate costs to purposes so that each purpose is economically justified provided that two requirements of project formulation are met:

(a) The overall benefit-cost ratio is favorable.
(b) The cost of adding each purpose as the last increment (separable cost) does not exceed the benefits derived therefrom.

The Separable Costs - Remaining Benefits Method normally requires the following data:

a. Estimated total installation cost of the multiple purpose structure (do not include project admin. costs).

b. Estimated benefits for each purpose.

c. Estimated alternate cost of achieving the benefits shown in step b. (w/o project admin. cost).

d. O & M, for the multiple purpose structure, for each of the alternates, and for the separable costs.

e. Capitalized values for the benefits and O & M figures. Capitalize at interest rate currently used for evaluation of water resource projects.

The following worksheet is one way to organize and make the cost allocation. The percentages in item 5 are used to allocate the joint costs in item 6. The total joint costs are the total installation costs minus the separate costs (item 4a). The percentages arrived at in item 7 will be needed to make the final allocation of the installation costs (item 8).

Some allocations will need one or two more steps after the worksheet is completed. If the reservoir is part of a recreational development the land rights cost will have to be allocated in accordance with paragraph b. 4 - Chapter 10, Economics Guide.

If part of the benefits are from two or more interdependent structural measures, such as a multiple purpose reservoir including irrigation as a purpose and the irrigation water distribution system, the installation costs, separable costs, and the O & M would have to include both measures. The installation costs other than the multiple purpose reservoir costs would be deducted after step 8 had been completed in the worksheet to obtain the reservoir cost allocation.

3. Alternative Justifiable Expenditure Method

(Also called the Specific Costs-Remaining Benefits Method) This method differs from the Separable Costs-Remaining Benefits Method only to the extent that specific costs are used rather than separable costs. The cost allocated to each purpose is equal to the specific cost plus the allocated joint cost.

A worksheet similar to the one used in the Separable Costs-Remaining Benefits Method can be used by changing separable costs to specific costs on the worksheet.

4. Allocation of Land Rights in a Public Recreational or Fish and Wildlife Development.

Cost sharing will be provided for the cost of land rights acquired by the sponsoring local organizations for public recreational or fish and wildlife purposes and for associated flood water detention. See paragraph 108.091 B W.P.H. However, cost sharing can be provided only for the land rights actually allocated to recreation or fish and wildlife. The allocation is based upon surface areas, not capacities. For example: the area required for the dam and reservoir is 1000 acres; the top of the recreation or fish and wildlife pool (incl. the sediment pool) is 200 acres; the top of the single purpose water supply pool is 600 acres; the single purpose flood prevention storage (up to the crest of the emergency spillway) is 800 acres. The area allocated to the water supply purpose would be 600 acres minus 200 acres or 400 acres. Thus, 400 acres or 40% of the land rights are allocated to the water supply purpose and 600 acres or 60% of the land rights are allocated to recreation or fish and wildlife and are eligible for cost sharing. If part, or all of the flood prevention storage was joint use storage, shared with the water supply purpose, that portion used jointly would be allocated to the water supply purpose.

Ponderosa Creek Watershed, Westernstate
Green Meadow Reservoir

Cost Allocation - Separable Costs - Remaining Benefits Method

Item	Purposes Flood Prev	Irrigation	Recreation	Totals
1. Benefits (Capitalized)	101,240	3,494,690	898,760	
2. Alternate Costs	420,380	2,781,100	659,310	
a. Installation Costs	(384,080)	(2,311,210)	(491,660)	
b. Capitalized O & M	(36,300)	(469,890)	(167,650)	
3. Benefits Limited by Alt. Costs (Lesser of Items 1&2)	101,240	2,781,100	659,310	
4. Separate Costs	8,800	2,203,750	363,930	2,576,480
a. Installation Costs	(7,920)	(1,775,480)	(220,780)	(2,004,180
b. Capitalized O & M	(880)	(428,270)	(143,150)	(572,300
5. Remaining Benefits (Item 3-Item 4)	92,440	577,350	295,380	965,170
	(9.58 %)	(59.82 %)	(30.60 %)	(100
6. Allocated Joint Installation Cost	51,320	320,480	163,930	535,730
7. Total Allocated Installation Costs	59,240	2,095,960	384,710	2,539,910
	(2.33 %)	(82.52 %)	(15.15 %)	(100
8. Summary of Allocated Installation Costs				
a. Construction Cost	46,490	1,646,450	302,280	1,995,220
b. Engineering Services	9,190	325,520	59,770	394,480
c. Land Rights	3,500	123,950	22,760	150,210
d. Total Installation Costs	59,180	2,095,920	384,810	2,539,910

Prepared by KRCromwell Date 1/9/70